June 1955

VOL. 67, No. 2 PAGES 73–152

The Wilson Bulletin

Published by

The Wilson Ornithological Club

at

Lawrence, Kansas

THE WILSON ORNITHOLOGICAL CLUB

Founded December 3, 1888

Named after ALEXANDER WILSON, the first American ornithologist.

President—Burt L. Monroe, Ridge Road, Anchorage, Kentucky.

First Vice-President—John T. Emlen, Jr., Dept. of Zoology, University of Wisconsin, Madison 6, Wisconsin.

Second Vice-President—Lawrence H. Walkinshaw, 1703 Central Tower, Battle Creek, Michigan.

Treasurer—Ralph M. Edeburn, Dept. of Zoology, Marshall College, Huntington 1, West Virginia.

Secretary—Phillips B. Street, Route 1, Chester Springs, Pennsylvania.

Membership dues per calendar year are: Sustaining, $5.00; Active, $3.00 THE WILSON BULLETIN is sent to all members not in arrears for dues.

WILSON ORNITHOLOGICAL CLUB LIBRARY

The Wilson Ornithological Club Library, housed in the University of Michigan Museum of Zoology, was established in concurrence with the University of Michigan in 1930. Until 1947 the Library was maintained entirely by gifts and bequests of books, pamphlets, reprints, and ornithological magazines from members and friends of The Wilson Ornithological Club. Now two members have generously established a fund for the purchase of new books; members and friends are invited to maintain the fund by regular contributions, thus making available to all Club members the more important new books on ornithology and related subjects. The fund will be administered by the Library Committee, which will be glad for suggestions from members on the choice of new books to be added to the Library. H. Lewis Batts, Jr., Kalamazoo College, Kalamazoo, Michigan, is Chairman of the Committee. The Library currently receives 65 periodicals as gifts and in exchange for *The Wilson Bulletin*. With the usual exception of rare books, any item in the Library may be borrowed by members of the Club and will be sent prepaid (by the University of Michigan) to any address in the United States, its possessions, or Canada. Return postage is paid by the borrower. Inquiries and requests by borrowers, as well as gifts of books, pamphlets, reprints, and magazines, should be addressed to "The Wilson Ornithological Club Library, University of Michigan Museum of Zoology, Ann Arbor, Michigan." Contributions to the New Book Fund should be sent to the Treasurer, Ralph M. Edeburn, Dept. of Zoology, Marshall College, Huntington 1, West Virginia. (Small sums in stamps are acceptable). A complete index of the Library's holdings was printed in the September 1952 issue of the *The Wilson Bulletin*, and each September number lists the book titles in the accessions of the current year. A brief report on recent gifts to the Library is published in every issue of the *Bulletin*.

THE WILSON BULLETIN

The official organ of The Wilson Ornithological Club, published quarterly, in March, June, September, and December, at Lawrence, Kansas. In the United States the subscription price is $3.00 a year, effective in 1951. Single copies, 75 cents. Outside of the United States the rate is $3.25. Single copies, 85 cents. Subscriptions, changes of address and claims for undelivered copies should be sent to the Treasurer. Most back issues of the *Bulletin* are available (at 50 cents each for 1950 and earlier years, 75 cents each for 1951 and subsequent years) and may be ordered from the Treasurer.

All articles and communications for publication, books and publications for review should be addressed to the Editor. Exchanges should be addressed to The Wilson Ornithological Club Library, Museum of Zoology, Ann Arbor, Michigan.

Entered as second class matter at Lawrence, Kansas. Additional entry at Ann Arbor, Michigan.

THE WILSON BULLETIN

A QUARTERLY MAGAZINE OF ORNITHOLOGY

Published by The Wilson Ornithological Club

Vol. 67, No. 2 | JUNE, 1955 | Page 73–152

CONTENTS

GREAT CURASSOW, painting by *George Miksch Sutton* ..... facing page 75

GREAT CURASSOW ..... *George Miksch Sutton* 75

VARIATION IN RELATIVE HEART SIZE OF CERTAIN PASSERINES WITH INCREASE IN ALTITUDE ..... *Robert A. Norris and Francis S. L. Williamson* 78

A NESTING STUDY OF THE LITTLE BLUE HERON IN EASTERN ARKANSAS ..... *Brooke Meanley* 84

ARTIFICIAL INCUBATION OF SOME NON-GALLIFORM EGGS ..... *Richard R. Graber* 100

SUMMER ACTIVITIES OF THE LAPLAND LONGSPUR ON BAFFIN ISLAND ..... *George M. Sutton and David F. Parmelee* 110

BEHAVIORAL MIMICRY IN THE TITMICE (PARIDAE) AND CERTAIN OTHER BIRDS ..... *Charles G. Sibley* 128

GENERAL NOTES

A POSSIBLE CASE OF POLYMORPHISM IN THE LEAD-COLORED BUSH-TIT ..... *Mary Anne Heimerdinger* 133

BLACK-BILLED CUCKOO FEEDS ON MONARCH BUTTERFLY ..... *Walter Dawn* 133

A MAY RECORD OF THE WHITE-WINGED CROSSBILL IN MICHIGAN ..... *T. Wayne Porter and Aelred D. Geis* 134

NOTES ON A HERON ROOKERY IN NORTHEASTERN OKLAHOMA ..... *John S. Tomer* 134

AN ELEVATED NEST OF A BARN SWALLOW ..... *Joseph J. Hickey* 135

THE INCUBATION PERIOD OF THE CAPE WHITE-EYE ..... *J. M. Winterbottom* 135

AN EXTENSION OF THE BREEDING RANGE OF THE KILLDEER IN FLORIDA ..... *Fred D. Bartleson, Jr.* 136

NOTES ON THE MYOLOGY OF THE GREAT CURASSOW ..... *Andrew J. Berger* 136

NOTES ON THE SONGS OF LARK BUNTINGS ..... *Jerry E. Stillwell and Norma J. Stillwell* 138

FOOD-STORING IN THE SPARROW HAWK ..... *Harrison B. Tordoff* 139

SIZE OF HOME RANGE IN EIGHT BIRD SPECIES OF A SOUTHERN ILLINOIS SWAMP-THICKET ..... *Richard Brewer* 140

NUMBER OF FEATHERS AND WEIGHTS OF VARIOUS SYSTEMS IN A BALD EAGLE ..... *Pierce Brodkorb* 142

EDITORIAL NOTES 143

LETTER TO THE EDITOR 144

ORNITHOLOGICAL LITERATURE 146

Alexander Sprunt, Jr., *Florida Bird Life*, reviewed by J. C. Dickinson, Jr.; Austin L. Rand, *Social Feeding Behavior of Birds*, reviewed by Herbert Friedmann; *VI Bulletin of the International Committee for Bird Preservation*, reviewed by J. Delacour; *Check-list of the Birds of Great Britain and Ireland*, reviewed by Alexander Wetmore; A. J. Marshall, *Bower-birds. Their Displays and Breeding Cycles*, reviewed by A. L. Rand.

GREAT CURASSOW OR *FAISÁN REAL*
(*Crax rubra*)

Adult male in breeding condition. Painted in the field from a specimen collected March 2, 1938, along the Río Sabinas, near the village of Gómez Farías, Tamaulipas, México, by George Miksch Sutton. This plate, which first appeared in Sutton's *Mexican Birds* (copyright 1951), is here used by courtesy of the University of Oklahoma Press.

GREAT CURASSOW

BY GEORGE MIKSCH SUTTON

SIXTY-SOME kilometers south of Victoria, Tamaulipas, the Mexico City highway crosses a beautiful stream, the Río Sabinas. West of the bridge a few miles rises the first foothill of the great Sierra Madre Oriental. The foothill is heavily forested; but the careful observer will note, well up the slope, a patch of naked, red-tinted rock, and at about the same level, a little to the north, a white cloud which seems to be caught in the trees. Under this cloud-banner—or, indeed, in it, for it clings to the slope much of the time—grow huge "*jobo*-plum" trees (probably *Spondias mombin*) whose uppermost branches bear thousands of yellow-orange "plums" in March and April. On this fruit feeds a remarkable bird, the Great Curassow (*Crax rubra*). The lofty trees are a favorite haunt of another cracid, the Crested Guan (*Penelope purpurascens*), and off to the north and east a few miles, in brushy, comparatively dry "mesa country," lives a third big galliform bird, the Wild Turkey (*Meleagris gallopavo*). These forms have survived principally because so few people living thereabouts have owned firearms. They probably will continue to survive, despite the proximity of the highway, if the traffic will be good enough to keep on moving.

The Río Sabinas is near the north edge of the Great Curassow's range. The species inhabits heavy tropical woodland southward through Middle America and western Colombia as far as western Ecuador (Peters, 1934. "Check List of Birds of the World," 2:12). A small race is endemic to Cozumel Island, off the coast of Yucatán. In southern Tamaulipas, where *Crax rubra* is found up to at least 3300 feet elevation, the bird is known as the *Faisán Real* (Royal Pheasant). In some parts of México, and in Guatemala, it is called the *Pahuil* (Salvin and Godman, 1897. "Biologia Centrali-Americana," Aves, 3:272), a name which strikes me as being a local version of *Pavo real*, the name used in Panamá (Aldrich and Bole, 1937. *Sci. Publ. Cleveland Mus. Nat. Hist.*, 7:53). Wetmore (1943. *Proc. U. S. Nat. Mus.*, 93:243) states than in one area of southern Veracruz the bird's name is *Cholín*.

The adult male Great Curassow is black with white belly, flanks, and under tail coverts. The black is faintly glossed with dark green and blue. The stiff, narrow crest feathers, each strongly recurved at the tip, give the head a fantastically tousled appearance when the bird is excited. The heavy bill is ornamented at the base with a yellow knob which swells and brightens at the height of the courtship season. The iris is dark brown. Young males are female-like in color for a time just after the post-natal molt, but they become boldly black and white long before reaching full size. A young male in my

collection, taken by Paul S. Martin in southwestern Tamaulipas on March 26, 1949, is much like an adult male except that it is decidedly small, its crest feathers are only slightly recurved, it has no bill-knob (label comments indicates that the cere was "bright yellow"), the feathers of the chin and throat are dull white basally, and there are a few brown- and gray-edged feathers among the greenish black feathers of the chest and upper belly.

In several adult male Tamaulipas specimens which I have handled in the flesh, the bill-knob has been large and almost spherical. The male shown in Sturgis (1928. "Field Book of the Birds of the Panama Canal Zone," opp. p. 26) has no bill-knob whatsoever, so either the bird was young or the photograph was taken at some season other than the breeding season.

The adult female is brown, without white on the belly and crissum, but with crest even more bizarre than that of the male in that it is black and white. The color of the upper parts is highly variable. Concerning this variability Sclater and Salvin (*Proc. Zool. Soc. London,* 1870:514) say: "In some specimens the wings are wholly red, in others much banded with black and cinnamomeous; in some specimens also the tail-bands are very slight, and almost evanescent. The upper portion of the back varies from black to chestnut." Friedmann (1946. *U. S. Nat. Mus. Bull.* 50, part 10:15) calls attention to the interesting fact that all specimens of the barred-backed "*chapmani* Nelson" form known to him have come from Campeche and Yucatán.

The sound produced by the male Great Curassow during courtship is simple but impressive. It has the muffled quality of a distant explosion. The individual whose portrait we present here produced a sound which I have set down as *oomh* (Sutton, 1951. "Mexican Birds," pp. 164–165). I use the word *sound* rather than *callnote* because I do not know to what extent the *oomh* is really vocal. The neck-skin of a courting male which I collected along the Río Sabinas on March 15, 1941, was thick and flabby, the muscular subcutaneous tissues being supplied with a considerable network of blood vessels. Such apparatus clearly indicates that the explosive quality of the *oomh* might result from a sudden releasing or powerful expulsion of a neckful of air. Salvin and Godman (*loc. cit.*) liken this sound to "the distant roaring of the 'tiger'." Cries of parent birds, excited over possible danger to their young, include "screams, peculiar grunts, and wails" (Sutton and Pettingill, 1942. *Auk,* 59:11).

All species of the family Cracidae are known to be arboreal, but the Great Curassows I have observed in southern Tamaulipas have certainly spent less time in trees than the Crested Guans of the same areas. Salvin and Godman (*loc. cit.*) say that in the morning and evening *Crax rubra* is "usually found perched upon trees and feeding on fruit, but during the day [it] spends its time chiefly on the ground scratching in the leaves for food . . ." As for

Penelope purpurascens, I have only very rarely seen it on the ground; *Crax rubra* I have seen on the ground several times, notably on March 21, 1941, when a female, near her nest or accompanied by small young, ran back and forth through the brush calling *kwut, kwut*, and giving a thin, penetrating squeal. Dickey and van Rossem (1938. *Field Mus. Nat. Hist. Zool. Ser.* 23: 147), writing of El Salvador, tell of surprising a dozen females and young which, instead of taking wing, all trotted into cover of the swamp in the manner of turkeys. These authors describe the flight of *Crax ruba as* "alternate flapping and sailing," the wing-beats as "powerful and rather slow."

The Great Curassow's nest is an unsubstantial, unshapely, disproportionately small structure of leaves, twigs, or a mixture of the two, placed in deep woods, but not very far from the ground. A nest found by the Cornell University-Carleton College Expedition near Gómez Farías, Tamaulipas, on March 17, 1941, was in a "vine-covered clump of slender trees . . . twenty feet from the ground. Here the female was incubating. From far up the slope we could see her dark tail and tousled crest" (Sutton and Pettingill, *loc. cit.*). The eggs, which are large, white, and rounded rather than pointed, usually number two.

The newly hatched chick, which I have never seen, has been figured by Heinroth (1931. *Journ. für Ornith.*, 79, opp. p. 282) as warm grayish buff, with white chin, throat, and belly, marked with black or deep chestnut on the head, neck, back and wings. Eggs are often taken from the nests by the Mexicans and hatched under domestic hens. The chicks grow up tame. I have seen two such pets, fully matured, walking sedately about in front of a fine home on the outskirts of Monterrey, Nuevo León.

R. I. Pocock (1908. *Avicultural Mag.*, 7:23–30) reports the breeding in captivity (in England) of a pair of Great Curassows. The nest, of willow twigs, was built solely by the male. The young, which were remarkably precocial, were fed by the female.

For many years I have been puzzled by the beautiful Fuertes drawing of a curassow illustrating his famous paper on the voices of tropical birds (1918. *Bird-Lore*, 16:427). When I first became acquainted with *Crax rubra* in southwestern Tamaulipas, I thought that Fuertes's drawing of the Colombian bird represented a male *rubra* with undeveloped bill-knob. I now feel quite sure that his model was an adult *Crax nigra*, probably a female, since the only specimen of *nigra* listed by Chapman (1907. *Bull. Amer. Mus. Nat. Hist.*, 36:194) is a female from Buena Vista, Colombia, the very locality at which Fuertes reported hearing a "Black Curassow."

Department of Zoology, University of Oklahoma, Norman, Oklahoma, February 20, 1955

VARIATION IN RELATIVE HEART SIZE OF CERTAIN PASSERINES WITH INCREASE IN ALTITUDE

BY ROBERT A. NORRIS AND FRANCIS S. L. WILLIAMSON

RENSCH (1931) has attempted to show that in certain passerines (*Dicaeum igniferum, Acmonorhynchus annae,* and *Cinnyris jugularis ornata*) from tropical regions the ratio of heart weight to body weight, or "heart ratio," increases markedly with increase in altitude. Although Rensch's data and conclusions were accepted by Stresemann (1927–1934), Moreau (1944) maintained that whereas such a trend might be expected on physiological grounds, the evidence presented by Rensch was unsatisfactory. Because Rensch had only small series of specimens and had not fully explained the method by which his data were obtained, Moreau expressed the need of standardized procedure by listing and briefly discussing possible sources of error. These sources included differences in age, sex, or physiological condition of specimens; in time of day of collection (birds weighing more in the afternoon than in the early morning); in lapse of time between collecting and weighing (the longer the time, the greater the weight loss through desiccation); in method of collecting (if shot, loss in body weight possibly resulting from loss of blood); and in preparation of hearts for weighing. Moreau also pointed out the need of larger series, statistical treatment of data, and investigation of intrapopulation variation as a necessary preliminary to comparison of populations at different altitudes. While Moreau's critique in general seems valid, we believe nevertheless that Rensch's data, albeit scanty, do provide a rough reflection of an actual pattern of increasing heart ratio in birds with increasing altitude.

Even before the appearance of Rensch's paper, Clark (1927:79,80) made the generalization that "animals living in cold climates appear to have higher heart ratios than similar animals living in warmer climates." Clark's evidence was based on reports by Strohl and by Hesse who dealt with ptarmigan (two species of *Lagopus*), House Sparrows (*Passer domesticus*), and squirrels (*Sciurus vulgaris*), comparing high-latitude or high-altitude forms with their counterparts from warmer regions. As these findings suggest and as Moreau (*op. cit.*) readily granted, an increase in heart size relative to body size at high altitude might be expected not only because of cooler temperatures but also because of the more rarified air. The following data on twelve species of passerine birds from a Temperate Zone region provide further evidence for the relationship between heart ratio and altitude (Fig. 1).

METHODS

Most of the specimens furnishing ratio values used in Figure 1 were taken with shotguns, placed in paper cones, and weighed within a few hours. The

birds were weighed to the nearest 0.1 grams on a double-beam balance; the hearts, to the nearest 0.01 grams on a triple-beam balance. It was found through testing that weights of hearts freshly excised and prepared (which included cutting off stumps of blood vessels and removal of blood or clots from the auricles) were not significantly different from weights of the *same* hearts preserved in 10 per cent formalin and later re-weighed. Specifically, among 84 hearts of Scrub Jays (*Aphelocoma coerulescens*) and Steller Jays (*Cyanocitta stelleri*) so treated, there was a mean weight loss of 1.56 per cent in the preserved hearts. Hearts in formalin were therefore considered comparable to ones freshly weighed. All the high-altitude data included in the present report pertain to weights of formalin-fixed hearts (all removed from solution, carefully trimmed, washed out, gently blotted, and weighed by the senior author). No attempt was made to correct for possible weight loss of the order of 1 or 2 per cent. All the lower-altitude data pertain to fresh-heart weights (again prepared and weighed by the same person in a standard way). The high-altitude specimens were obtained in the White Mountains of extreme east-central California and adjacent Nevada by the junior author, who accompanied a collecting expedition led by W. C. Russell and sponsored by the Museum of Vertebrate Zoology. The hearts of passerines taken at elevations from 6750 to 10,500 feet were excised and labeled individually (being pierced with insect pins bearing heavy-paper tabs for field catalog numbers). Thus, hearts could later be associated with individual specimens and their corresponding body weights.

Most of the specimens of lower-altitude populations represented in Figure 1 were obtained at elevations between 100 and 800 feet, usually in Alameda, Contra Costa, or Marin counties in central-coastal California. Exceptions are (1) the "lower-altitude" specimens of *Cyanocitta stelleri*, which were shot in Tuolumne County, California, at approximately 2000 feet, and (2) the Yellow throats (*Geothlypis trichas*) and Chipping Sparrows (*Spizella passerina*), of which the lowland samples came from southern Georgia. It should be added that the lowland Fox Sparrows (*Passerella iliaca*) were wintering birds from near Berkeley, California. While it is possible that these Fox Sparrows represent breeding stock from high altitudes, it is not likely that they do. With these exceptions, the highland and lowland samples were both taken shortly before or during the breeding season and are both essentially Californian, coming from high Sierran and low coastal hill regions, respectively.

Extremely fat specimens were not used in this study. In specimens with limited deposition of subcutaneous and intraperitoneal fat, there is also some deposition on the heart, this tending to minimize variability in the ratios. For the present we are assuming that the myocardium does not undergo seasonal

variation in size. Because this report is of preliminary nature, the assigning of geographic race names to populations is deemed unnecessary.

Acknowledgments

Most of the jays (*Cyanocitta* and *Aphelocoma*) were salvaged from a jay shoot in Tuolumne County, California, by Dr. Frank A. Pitelka. Robert S. Hoffman, Victor Lewin, Jr., and Ralph J. Raitt were helpful in providing a number of the fringillids. Determination of ratios was facilitated by use of a calculator in the Museum of Vertebrate Zoology.

Results and Discussion

The graphs shown in Figure 1 are rather striking in that heart ratios of high-montane samples or individuals are higher in all species than are ratios from lower altitudes. The trend lines for *Cyanocitta stelleri* approach the vertical more closely than those of other species; this might be due not only

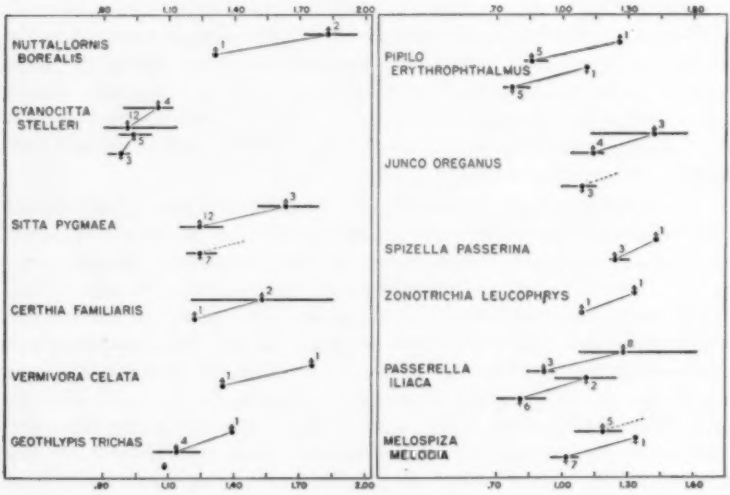

Fig. 1. Variation in heart ratio (heart weight divided by total body weight) of twelve passerine species in relation to altitudinal increase. Sex symbols designate both the sex and mean (or sole, individual) ratio; for each species, symbols to the right refer to the higher altitudes; small numbers near symbols show the number in the sample; heavy horizontal lines indicate the range of ratio values for a given sample; diagonal lines connecting like symbols serve to accentuate the regular trend toward higher heart ratio with increasing altitude.

to the fact that the "lowland" population itself came from 2000 feet, but also because of the large size of jays in comparison with the other passerines. Whatever the altitude, both *Cyanocitta stelleri* and certain fringillid species show higher heart ratios in males than in females. (This is likewise true of *Aphelocoma coerulescens* and other passerines not included in Figure 1.) In the lowland population of Pigmy Nuthatch (*Sitta pygmaea*) the sexes average the same. The two montane specimens of Brown Creeper (*Certhia familiaris*) show marked and probably aberrant difference in heart ratio, due possibly to desiccation or to technical error; both this sample and those of other species, notably the Orange-crowned Warbler (*Vermivora celata*), *Geothlypis trichas*, *Spizella passerina*, and the White-crowned Sparrow (*Zonotrichia leucophrys*) are admittedly poor and unsatisfactory, but since trends suggested by them agree with those shown by other species, they are included in Figure 1.

TABLE 1

PRECISE VALUES FOR THE DATA PLOTTED IN FIGURE 1
Samples are represented by extreme ratios and means (in parentheses)

Species	Lowland Males	Highland Males	Lowland Females	Highland Females
Olive-sided Flycatcher, *Nuttallornis borealis*	1.31	1.72, 1.96		
Steller Jay, *Cyanocitta stelleri*	0.80–1.14 (0.91)	0.89–1.12 (1.01)	0.82–0.92 (0.88)	0.87–1.02 (0.94)
Pigmy Nuthatch, *Sitta pygmaea*	1.15–1.35 (1.24)	1.52–1.79 (1.64)	1.18–1.32 (1.24)	
Brown Creeper, *Certhia familiaris*	1.22	1.20, 1.86		
Orange-crowned Warbler, *Vermivora celata*	1.35	1.76		
Yellowthroat, *Geothlypis trichas*	1.03–1.26 (1.14)	1.39		
Spotted Towhee, *Pipilo erythrophthalmus*	0.83–0.93 (0.87)	1.26	0.73–0.85 (0.77)	1.11
Oregon Junco, *Junco oreganus*	1.04–1.19 (1.14)	1.13–1.57 (1.42)	1.00–1.16 (1.09)	
Chipping Sparrow, *Spizella passerina*	1.22–1.31 (1.27)	1.43		
White-crowned Sparrow, *Zonotrichia leucophrys*	0.83	1.33		
Fox Sparrow, *Passerella iliaca*	0.84–0.97 (0.92)	1.08–1.62 (1.28)	0.70–0.93 (0.81)	0.97, 1.25
Song Sparrow, *Melospiza melodia*	1.06–1.28 (1.19)		0.95–1.08 (1.02)	1.34

Hartman (1954), in a report on cardiac and pectoral muscles of trochilids, states: "In a series of 300 species and subspecies of birds which I have collected, only 12 possessed hearts 1.5 per cent or more of the body weight. From the activity of hummingbirds, the relatively greater size of the hearts [their ratios ranging from 1.74 to about 2.40] might be expected." Although this thought on hummingbirds is certainly justified by Hartman's quantitative information, the first statement, which applies presumably to a large

proportion of passerine species, leads us to suspect that very few, if any, of his specimens were obtained at high altitudes. The data on hummingbirds are well presented (*ibid.*), but the heart-ratio values are not separated according to sex. It would be interesting to know whether male hummingbirds resemble male passerines in having relatively larger hearts than do females. Hartman's trochilid species, excepting the Ruby-throated Hummingbird (*Archilochus colubris*), were obtained in Panama, presumably at relatively low elevations. If, however, certain of his species are represented by both mountain and lowland specimens, it would seem desirable to re-examine the data because of the possibility of altitudinal differences comparable to those indicated for passerines.

Further analysis of variation of heart ratio in birds in relation to altitude, sex, activity, and other matters will be made at a later time. It is sufficient to say at present that in both intra- and interspecific comparisons, both altitudinal and sexual differences provide variables to be reckoned with. Too, in making analyses, one should distinguish nicely between intra- and interspecific variation. To illustrate: in twelve male *Sitta pygmaea*, from 200 to 600 feet in central coastal California, the heart ratios averaged 1.24 (1.15–1.35); in ten male Brown-headed Nuthatches (*Sitta pusilla*), a closely related species taken at approximately 350 feet in Georgia, the ratio averaged 1.56 (1.42—1.68). Similarly, in seven female *pygmaea* the ratio was 1.24 (1.18—1.32); in five female *pusilla* it was 1.47 (1.38—1.56). Whether or not these samples are segregated by sex, there is no overlap between even the extreme heart ratios in these two species of *Sitta*. Curiously, the species *pusilla*, living in a generally warmer climate, has the significantly larger heart (body size in the two compared populations being almost identical). Hence factors influencing such a ratio difference might well relate to intrinsic biological characteristics of the species more than to effects of the physical environment.

Conceivably, measurements of heart ratios of birds will in time be helpful to the taxonomist, not only in the matter of describing and defining closely related species but also in the matter of identification of high-altitude or, perhaps, high-latitude subspecies taken in migration or on wintering areas. It seems probable that such measurements will also be useful to avian physiologists, as has been suggested by Odum (1941:315).

Summary

Evidence from twelve species of passerine birds points to higher heart ratios in high-altitude populations. Such variation in relative heart size, which might be expected on physiological grounds, lends support to earlier findings of Rensch (1931) based on three tropical species. Both altitudinal and sexual differences contribute importantly to variation in heart ratio in

birds as illustrated by passerines, and these variables among others ought to be considered in the analysis of heart-ratio data.

Literature Cited

Clark, A. J.
1927 Comparative physiology of the heart. (New York; The Macmillan Company).

Hartman, F. A.
1954 Cardiac and pectoral muscles of trochilids. *Auk*, 71:467–469.

Moreau, R. E.
1944 Rensch on the increase of heart-weight in relation to body-weight with increase in altitude. *Ibis*, 86:30–32.

Odum, E. P.
1941 Variations in the heart rate of birds: a study in physiological ecology. *Ecol. Monogr.*, 3:299–326.

Rensch, B.
1931 Der Einfluss des Tropenklimas auf den Vögel. *Proc. 7th Internat. Ornith. Congr.*, 1930:197–205.

Stresemann, E.
1927–1934 Aves, *in* Kükenthal's Handbuch der Zoologie, vol. 7, pt. 2:i–xi + 1–897 pp.

Department of Zoology, Rutgers University, New Brunswick, New Jersey, and Museum of Vertebrate Zoology, Berkeley 4, California, January 18, 1955

A NESTING STUDY OF THE LITTLE BLUE HERON IN EASTERN ARKANSAS

BY BROOKE MEANLEY

THE nesting of the Little Blue Heron (*Florida caerulea*) has been observed in its coastal and inland habitats on many occasions, as cited by Bent (1926), Howell (1932), Sprunt and Chamberlain (1949), and others. Most of the heronries discussed in these publications were located on coastal marsh islands or about lakes in the interior. Such heronries, usually isolated from human activity, often are difficult to keep under observation.

The following observations were made during 1952, 1953, and 1954 (mostly in the latter year) at a heronry located within 200 yards of the village of Swan Lake, Jefferson County, Arkansas. The Swan Lake heronry was described briefly in a recent paper by the writer (1954).

It has been reported reliably that this heronry has been in continuous use at least since 1938, the year that the informant moved within sight of it. In spite of its proximity to civilization, the site obviously was chosen because an extensive growth of buttonbushes (*Cephalanthus occidentalis*) at one end of the lake furnished ideal nesting habitat, and because areas of ready access provided an abundance of food.

The location of this heronry was similar to one found by M. G. Vaiden at Benoit, Mississippi. Both heronries were situated on the outskirts of a small village, were surrounded by delta cotton fields, and were about two miles from a river, in sight of the river levee.

METHODS

It was possible to drive to within about 40 yards of the Swan Lake heronry along a well-used farm road and to make observations from the car window; or to sit on the front porch of one of two tenant houses nearby and watch nest building, feeding of young, and other activities.

The use of a blind was unnecessary until after hatching, as it was possible for an observer to approach to within 20 to 30 feet of the nests and to watch the herons with or without binoculars as they went unconcernedly about their ways. When first disturbed the herons would simply fly a few yards away, returning to their nests soon after the intruder stopped moving. The birds became less tame after the eggs hatched.

The role of the sexes in most of the early phases of nesting behavior was revealed by the activities of individuals immediately following copulation.

ACKNOWLEDGMENTS

The writer is indebted to E. R. Kalmbach, and to Robert E. Stewart, Charles C. Sperry and Paul Hickie of the Fish and Wildlife Service for reviewing the manuscript; and to Anna Gilkeson Meanley for assisting in the field work.

Nesting Habitat

The old riverbed lake in which the heronry was located is known as Old Crow Lake. The lake is fringed on the north and northwest sides by willow (*Salix nigra*) and on the south, southwest and southeast sides by buttonbush, swamp privet (*Forestiera acuminata*), and willow, in order of abundance as named. The buttonbushes actually extend en masse more than 100 feet out into the lake, occupying several acres at the south end.

Fig. 1. Adult Little Blue Herons near nests in buttonbushes at Swan Lake, Arkansas, May 20, 1954.

The Little Blue Heron nesting colony was located mostly along the southeastern side of the lake, while most of the nesting associates, discussed elsewhere by the writer (1954), occupied the south and southwest sides. Although there was some mixing of the species, Little Blue Herons selected the sites closest to land, American Egrets (*Casmerodius albus*) ranged in an intermediate section, and Snowy Egrets (*Egretta thula*) built in the outermost bushes near the open water, and at a lower level than the other species. At least three-fourths of the Little Blue Heron nests were in buttonbushes; the remainder in swamp privet (Fig. 1).

The water beneath most nests averaged two feet in depth during the early part of the nesting season. Since there usually is less precipitation in June and July the water level fell in mid-summer, exposing the lake bottom beneath the nests.

Arrival of Migrants

The spring arrival of Little Blue Herons at Swan Lake usually is timed with the blooming of the swamp privet. The earliest spring arrival recorded was March 13, 1954, when four birds were observed. In two previous years Little Blues began arriving about the middle of March or shortly thereafter. In 1953 several pairs were feeding small young by April 21, which indicates they must have been at Swan Lake by mid-March; and on March 23, 1952, 400 birds were estimated at the heronry.

By March 27, 1954, due to an unusually prolonged cool period with daily minimum temperatures between 40° F. and 50° F., only a small segment of the nesting population had arrived at the colony, and there were no signs of mating. Wintering or migrant waterfowl using the lake at that time included Mallards (*Anas platyrhynchos*), Blue-winged Teal (*Anas discors*), Lesser Scaup (*Aythya affinis*), and Coots (*Fulica americana*). Approximately 20,000 "blackbirds" (*Agelaius phoeniceus* and *Quiscalus quiscula versicolor*) were roosting in the buttonbushes and swamp privet.

Snowy and American egrets normally arrived during the third or last week in March with "snowies" usually putting in an appearance first. Water-turkeys (*Anhinga anhinga*), the last to arrive, were first seen on April 5, 1952, April 19, 1953, and April 14, 1954.

Several authors have reported all three color phases in a Little Blue Heron breeding colony. At Wilmot, Arkansas, in June, 1910, Arthur H. Howell (1911:26) wrote of finding the three phases about equally represented. Only the adult, blue phase birds were found nesting at Swan Lake. White and intermediate phase birds roosted at the heronry during the early part of the nesting season, but later they roosted near the rice fields in which most of them fed during the day.

Courtship Display

Data concerning courtship behavior were obtained between April 11 and 14, 1954. At this time some pairs already were mated and had started building nests.

Being unwilling to risk possible loss of later observations by collecting a displaying bird within the heronry itself, the writer did not determine the sex of any of the displaying birds.

Courtship display apparently takes place on the nesting territory and near the nest site eventually used, because in nearly every case observed nest construction was started subsequently near the courtship perch. Usually the same

perch was used for repetition of the display, although there was some shifting about to nearby perches in the same bush, and occasionally to nearby bushes.

On the morning of April 11 a displaying bird under observation performed in a buttonbush about eight feet above the water, the average nest height for this section of the colony. Most of the herons nearby were building nests. Perched about two and one-half feet above the displaying bird was the prospective mate. The displaying bird moved twice in a sort of pumping motion from an upright position to a crouch. As it assumed the crouching position the bird opened its bill slightly, but the observer could not be certain whether or not the heron was emitting a sound. During the act the bill was pointed upwards, the back and neck plumes were extended and spread, and the wings were either drooped or spread, or both. Upon resuming a normal standing position the bird twice swayed from side to side.

One Little Blue Heron repeated its performance seven times in 12 minutes, and, at another period during the same day, 17 times in 30 minutes. The prospective mate made threatening gestures at other herons that alighted near it on the same bush, but occasionally stretched its neck in the direction of the displaying bird, looked down, and clapped its mandibles with a rattling sound. The displaying bird then usually followed suit. The prospective mate sometimes attempted to work its way toward the displaying bird, which seemed to discourage it with scolding and a darting bill. However, the former eventually reached a perch near the displaying bird and pecked at its plumes. Both birds then crossed their outstretched necks and kept up a continuous rattling chatter for several minutes, biting at each other's plumes at the posterior part of the body. Once the displaying bird flew from the perch, circled about 30 yards over the lake and returned. The other heron left several times, but always returned within two or three minutes.

At least 20 males were observed in the act of courtship display and all followed a similar pattern; but in most cases there was no indication that a prospective mate was nearby. One individual displayed within three feet of an incubating bird. Courtship continued from sunrise until sunset.

Copulatory Behavior

Copulation commenced during the initial stages of nest building, and, as a rule, took place on the nest platform. During the egg-laying period it frequently followed closely the change-over at the nest (both male and female incubate, feed, and otherwise care for the young).

During copulation, the female assumed a partial or complete crouching position and the male grasped the female with his feet close to her body underneath the wings, just beneath the shoulders. In one case the male was seen to grasp the female on the outside of the bend of the wing or shoulders. The

male usually extended his wings to help maintain balance. When copulation was completed, the male stood up on the back of the female and stepped off to the side.

Promiscuity existed throughout the nesting colony, and many females were serviced more by foreign males than by their own mates. A male perched within a few inches of his incubating mate often moved over to a nearby nest, copulated with the incubating female there, and returned to his perch. This frequently was immediately preceded or immediately followed by copulation with his own mate. Females approached by foreign males sometimes stood up in their nests and fought off the males, but usually they submitted under protest; occasionally they made no effort whatsoever to ward off the promiscuous male, merely scolding it a bit after the act. Sometimes the mate of the female about to be attacked was able to prevent the intrusion; however, in at least one case I observed, the male was unable to do so. Intruding males usually approach the incubating females rapidly, whereas a female's own mate is usually much slower and more deliberate.

Promiscuous copulation was noted in 16 cases in a section of the colony during seven hours of continuous observation. Three foreign males were seen to copulate with the same female within a 45-minute period. One male attempted to copulate with five different females and was successful with four of them. In one case a foreign male attempted to copulate with an incubating male, remaining on the incubating bird during the normal period of coitus. This fact was confirmed when the latter bird's mate returned and was in turn mounted by the male, which had been incubating.

Nest Building

Nest building usually began during the last week in March or the first week in April. In 1951, Robert E. Stewart and the writer found eggs in some nests on April 10; in 1952 many pairs were building on April 5; in 1953 adults were feeding young in several nests by April 21, and therefore had constructed their nests during the third week in March; and in 1954 a few nests contained eggs by April 11, but most pairs were just beginning to build.

There seemed to be no inclination on the part of herons to use the previous year's nests, many of which were almost completely intact; nor were these herons seen to remove sticks from the old nests for use in new construction. When the opportunity availed itself they would remove sticks from other newly-built heron nests as well as from the nest of egrets and Anhingas. On the other hand American Egrets and Anhingas sometimes appropriated Little Blue Heron nests, adding material to them and otherwise fashioning them for their own use.

One American Egret made four trips in 30 minutes to a Little Blue Heron's nest to obtain sticks for use in the construction of its own nest. It removed

only the larger sticks, tossing the smaller ones aside. Several times while it was tugging at the larger sticks the heron's eggs almost rolled out of the nest. On another occasion, American Egrets, fighting over sticks from a Little Blue Heron's nest, shook the nest bush and all of the Little Blue's eggs fell into the water. One Little Blue Heron's nest, left unguarded, was raided by a Snowy Egret which picked up the eggs and dropped them into the water.

In the nest-building operation the male gathers most of the sticks, carrying them to the nest one by one and presenting them to the female, who works them into place. Julian S. Huxley (Bent, 1926:169), in his study of the Louisiana Heron (*Hydranassa tricolor*) at Avery Island, Louisiana, observed the same behavior. However, when the male is away from the vicinity of the nest the female sometimes gathers sticks. The male when alone at the nest, particularly during the egg-laying and incubation periods, frequently rearranges some of the sticks. One member of the pair nearly always remains at the nest during construction as well as the egg laying period, apparently to prevent removal of sticks by other birds.

Most of the sticks were gathered from the shallow water beneath the nest, but some were picked up from the dry land along the edge of the lake and occasionally they were brought in from a great distance. Frequently a bird which had been feeding brought in nesting material on the return trip. Herons often perched about six inches above the water, reaching out to pick up sticks floating by. Sometimes they waded out into the water to pick up a stick, and occasionally a heron would scoop up a stick from the water's surface while on the wing. Only occasionally were sticks broken from branches of the buttonbushes in which most of the herons were nesting.

Buttonbush twigs were used to make most nests (Fig. 2). A few weed stalks and stems were noted in many nests and one nest was constructed entirely of them. Other herbaceous material used in part for nest construction included stems and pods of a mallow (*Hibiscus* sp.) and those of a milkweed (*Asclepias* sp.). Green leaves were rarely found in nests.

A pair of herons was watched for several hours on April 14 while building a nest which at that time was in the initial stage of construction. Between 10:00 a.m. and 12:12 p.m. only one stick was brought to the nest. However, from 12:13 until 12:34 the male made six trips for sticks, never remaining at the nest for more than two or three minutes at a time. Another bird was observed to make seven trips for sticks in 12 minutes.

One heron continued to bring sticks three to four feet in length to its mate at a nest in the early stages of construction. The female dropped one 4-foot stick three times after spending several futile minutes attempting to place it in the crotch of the bush. The male continued to drop down into the water

after the stick, returning it to the female. That nest was never completed and all of the sticks eventually disappeared.

Nest building at the heron colony continued throughout the day, from early morning until dusk. However, at certain nests in various stages of construction, many hours went by when not one stick was added.

Most nests were nearly complete by egg-laying time, usually requiring from three to five days to reach this stage. However, in several nests there were barely enough sticks in the platform to keep the first egg from falling through. At two nests under close observation there was a lapse of six or seven days between the beginning of construction and the laying of the first egg.

Fig. 2. Nest and eggs of the Little Blue Heron, Swan Lake, Arkansas, May 20, 1954.

Following the change-over during egg-laying or incubation periods the male nearly always made several trips to the water beneath the nest to gather sticks. This is apparently a part of the greeting ceremony.

In one section of the colony, 58 nests were on the average eight feet above the water with a maximum of 15 feet and a minimum of three feet. Several nests in swamp privet were 25 feet above the water. As many as nine nests have been counted in a single buttonbush, and most bushes had at least five.

The Egg Laying Period

Five to eight days are required for a Little Blue Heron to lay a complete clutch of eggs, depending upon whether the clutch contained three, four, or

five eggs. Thus a single egg is deposited on an average of one nearly every other day (see Table 1).

Typical behavior during the egg-laying period is illustrated by the following record of the activities of one pair on April 17. The male was found standing over the single egg in the nest, which posture it alternated with an incubating one for the ensuing 35 minutes. When the female returned the male stood up in the nest. The female sidled in under the male, gently pushing him aside and began moving the egg about in the nest, then rearranging several sticks. Meanwhile the male walked out on a limb about two feet from the nest, where he remained for seven minutes. He returned to the nest and copulation took place. The female left the nest, returning after 25 minutes to move in under the standing male as before. Once again she moved the egg about and tugged at a few sticks before settling down upon the egg. A few minutes later a second egg was deposited and the female stood up in the nest where the male joined her. The two stood together some 15 minutes before the female left and the male settled down upon the eggs.

Each time one bird returned to the nest after being away for a time, elaborate greetings were exchanged. The pair would repeatedly call "*quip-a-quee, quip-a-quee*" to each other, peck at one another's plumes and cross outstretched necks. Although the latter displays gradually diminished and, at later stages, were discontinued, the vocal greetings were regularly exchanged between the members of the pair throughout nearly all phases of the nesting period.

Clutch Size

Bent (1926:179) says that, "The little blue heron usually lays four or five eggs, sometimes only three, and occasionally six." Clutch size in 50 nests at Swan Lake ranged from three to five eggs with an average of 4.04 per nest. Nine nests contained five eggs, 34 contained four eggs each, and seven contained three eggs. Additional eggs may have been laid in any of these nests, but could have been knocked out or removed.

Incubation

At virtually all nests under observation, incubation began after the laying of the second egg. This was evident not only from observations of incubating birds at nests containing only two eggs, but was confirmed in several nests at hatching time. Nests Nos. 7 and 12 (Table 1) contained four eggs on April 24 at 5:00 p.m. On May 10, at 5:00 p.m., there were two newly hatched young and two eggs in each nest. The following day at 12:00 noon there were still two eggs and two young in the nests.

Sprunt and Chamberlain (1949) list the incubation period of the Little Blue Heron as 21 to 23 days. The incubation period for the Swan Lake birds was 22 to 24 days; however 22 or 23 days was the rule (see Table I).

TABLE 1

EGG-LAYING AND HATCHING DATES AT 10 NESTS OF LITTLE BLUE HERONS, SWAN LAKE, JEFFERSON COUNTY, ARKANSAS, IN 1954.
(Number of eggs and/or young in individual nest)*

Date	Nest No. 1	Nest No. 2	Nest No. 3	Nest No. 4	Nest No. 5	Nest No. 6	Nest No. 7	Nest No. 8	Nest No. 9	Nest No. 10
Apr. 17	1 egg	1 egg	0 eggs	1 egg	2 eggs	2 eggs	1 egg	1 egg	2 eggs	2 eggs
Apr. 18	2 eggs	1 egg	1 egg	2 eggs	2 eggs	3 eggs	2 eggs	1 egg	3 eggs	3 eggs
Apr. 19	empty	2 eggs	1 egg	3 eggs	3 eggs	3 eggs	2 eggs	2 eggs	3 eggs	3 eggs
Apr. 20	—	3 eggs	2 eggs	3 eggs	3 eggs	4 eggs	3 eggs	2 eggs	4 eggs	4 eggs
Apr. 21	—	3 eggs	2 eggs	4 eggs	4 eggs	4 eggs	4 eggs	3 eggs	4 eggs	—
Apr. 22	—	4 eggs	3 eggs	4 eggs	—	5 eggs	—	4 eggs	5 eggs	—
Apr. 23	—	—	4 eggs	5 eggs	—	—	—	—	—	—
May 10	—	—	—	—	2 eggs 2 young	3 eggs 2 young	—	—	4 eggs 1 young	2 eggs 2 young
May 11	—	—	—	—	—	2 eggs 3 young	—	—	3 eggs 2 young	—
May 12	—	—	—	2 eggs 2 young	1 egg 3 young	1 egg 4 young	1 egg 3 young	2 eggs 2 young	2 eggs 3 young	4 young
May 13	—	2 eggs 1 young	—	—	—	—	—	1 egg 3 young	1 egg 4 young	—
May 14	—	—	2 eggs 2 young	—	—	—	—	—	—	—
May 15	—	2 young	1 egg 3 young	empty	4 young	4 young	3 young	4 young	empty	4 young

*Nests inspected for contents at 5:00 p. m.

The members of a pair seldom are together for any length of time during the incubation period. One bird was incubating at nest No. 7 when observations began at 10:58 a.m., April 24. At 12:31 p.m., the mate returned and the bird that was relieved left the scene immediately. On this same date at nest No. 6, after the change-over, the bird that had been incubating gathered sticks and presented them to the incubating bird for about 15 minutes, then left the scene. At another nest the mate flew in for the change-over at 11:45 a.m. It stopped about two feet short of the nest. The incubating bird then stood up, moved to the nearest nest (three feet away) and copulated with the bird on that nest, then climbed about three feet above its own nest and preened as its mate moved in and settled on the eggs. In about a minute it left the area.

The typical routine of the incubating bird was recorded during an hour's watch on April 24: At 11:20 a.m. (temperature 85° F.) bird at nest standing over five eggs, shading with drooped wings, bill open and apparently panting; at 11:24 bird settled on eggs with bill open and panting; between 11:28 and 12:20 p.m. it stood up in nest six times, twice to chase off intruding Little Blues, once when a tractor passed by 40 yards away, and three times to preen or rearrange sticks in nest.

In 1954 hatched young were noted in nests during the first week in May, but the peak of the hatching period was toward the latter part of the second week in May. In three previous nesting seasons the first young were found in nests during the third or fourth week in April.

Within a few minutes after hatching, the egg shell is tossed out of the nest by the adult in attendance.

Care and Behavior of Young

Incubation and brooding overlap at hatching time because it takes from three to five days for the entire clutch to hatch. The young therefore are brooded much of the time during their first week of life. At one nest, newly hatched young were covered by an adult approximately 80 per cent of the time from 12:00 noon until 5:30 p.m. Both parents shared in brooding the young with the change-over essentially the same as during incubation.

During the first three or four days the young were fed upon regurgitated food dropped into the nest by the attending parent. The mass of food, if round in shape, was sometimes the size of a golf ball. The young lost no time in attacking the food, even appearing to choke on some oversized morsels.

On May 8, from 12:00 p.m. until 5:30 p.m., observations were made at nest No. 60 which at that time contained three young from two to three days old and two unhatched eggs. One parent bird remained at the nest until 3:14 p.m., occupying its time with brooding the young, shifting position, chasing off intruders, regurgitating food into the nest for the young on five different occasions, and nibbling at some of its regurgitated food. At 3:14 the mate re-

turned and resumed brooding. Two hours later it regurgitated food in the nest for the first time since its return.

By the end of the first week the method of feeding changed and the young were taking food from the parent's bill. This was done by grasping the parent's bill crosswise near the base and tugging at it until the regurgitated food was forthcoming. This procedure is well narrated by Dr. A. H. Cordier (cited in Bent, 1926:180), and similar behavior on the part of an American Egret is described by Bent (*op. cit.*:138).

When a foreign adult alighted near the nest the young poked their heads at the intruder and moved over toward it to be fed, but the adult bird only threatened them with poking bill and backed away or flew off. Sometimes the young attempted to move over to a nearby nest to be fed by the adult in that nest, but they were fast discouraged by the darting bill of that parent.

During the second week the young began to stand in their nests and to walk out short distances on nearby branches. However, most of the time was still spent in the nest where the parents brooded less, usually by merely standing over the young with wings drooped. Sometimes when a parent was perched several feet from the nest the young attempted to climb to it and grasp its bill for food.

Observations at nest No. 60 were continued for a short period of time on the afternoon of May 16. The young at this time were in their second week. Adults exchanged places at the nest at 2:55 p.m. During the next four minutes the parent at the nest fed the young, one four times, another three times, and a third twice, while the smallest or fourth received nothing. The adult standing on the edge of the nest with its back to the sun began brooding by bending its knees slightly, spreading its wings forward and parting its breast feathers. During a 20-minute siesta one of the young remained completely outside the canopy formed by the parent and slept with its bill tucked beneath its wing. The adult, again beset with demands for food, fed only one nestling at that time; then, after preening on a nearby perch for about 15 minutes, it returned to the nest and began to brood once again, pushing the young downward in the nest with its feet. The smallest young tried to get the parent to feed it, but there was no response. Seventeen minutes later the parent again moved out on a branch where it preened and rested approximately 24 minutes before returning. It left the nest when its mate returned at 4:33 p.m. The three older young were fed almost immediately by the returning parent. When they had obtained their fill the fourth and smallest was fed. Sometimes the smallest bird in the clutch picked up a scrap that was accidentally dropped by one of the older nestlings.

By the third week the young were spending more time out on the branches than in the nest, climbing awkwardly about branches, sometimes to the top-

most part of the bush to exercise their wings (Fig. 3). Occasionally a young bird lost its balance and fell part way off a branch, but by maintaining its grip it eventually regained its balance on the perch by the use of its neck, bill, feet and wings. The parents were never seen to offer any help in such a situation. During their third week three young birds which were placed in the water were able to maneuver well enough to return to the nest.

FIG. 3. Juvenile Little Blue Herons approximately one month old. Swan Lake, Arkansas, June, 1953.

The young generally remained closer to their own nests than to others, seldom wandering near other nests unless frightened. Straying young were chased away from other nests or nest bushes by the parent bird or the young of that nest. Juveniles out on branches near their nest returned to defend it. I have seen a young Little Blue Heron in its nest inflict painful blows at the neck of an intruding juvenile, sending it away as hurriedly as the itinerant could move; and I have seen this happen to the same stray bird three times in succession.

When a parent returned to its nest, young out on the branches usually hurried back to be fed. Occasionally one or two of the young failed to return and then the parent flew or walked to the branch to feed the young there. However, it was evident that parent birds preferred to feed the young in the nest.

The parents of young in the third week stayed away from nests for increasingly longer periods of time. I observed feeding of young by incoming parents at nests Nos. 90 and 8 at which there were periods of 2 hours, 8 minutes and 2 hours, 46 minutes respectively, during which no parent was in attendance.

By the time the young were a month old they were able to make short flights to nearby bushes or limbs. On August 1, 1953, I observed for some time the feeding of the juvenile birds some distance from the nest. A great many of the younger juveniles, about one month old, remained for the most part within a given area and the adult bird returned to that area to feed them. However, the older juveniles often followed the adult bird about the colony; sometimes two or three juveniles could be seen flying behind the adult bird as it circled far out over the lake. Some such flights lasted at least five minutes. When the adult finally came to a resting place the young were usually but not always fed. Generally when the adult returned with food it did not go directly to the young, but was pursued persistently from bush to bush until overtaken by them.

Since some of the juveniles move about so much it is entirely possible that they are fed by many different adult birds.

Nesting Success

Fifty nests were tagged so that nesting success could be appraised. Later, when young about two weeks of age began to wander widely and even join young from other nests, observations were concentrated on 30 of the 50 nests originally selected. The 124 eggs laid in 30 nests produced a total of 92 young reared to two weeks of age. Of 30 nests, 28 produced one or more 2-week-old young. In ten randomly-selected nests 32 young were hatched, and at two weeks, 26 had survived.

The principal cause of egg losses during the laying and incubation periods appeared to be nest robbing (for sticks) by other herons and egrets. Some eggs were infertile. Eggs laid in partially-completed nests may have rolled out or fallen through the meager platform during periods of high winds. Fish Crows (*Corvus ossifragus*) were seen stealing eggs on several occasions, and a Baltimore Oriole (*Icterus galbula*) was seen to puncture the eggs at one Little Blue Heron nest. Very small young were occasionally pushed out of the nest by the older siblings, or perhaps fell out.

The ponds or lakes over which many of the heronries in the lower Mississippi Valley are located dry up in June or July, thus exposing the young to attack by mammalian predators. At several nests, herons two or three weeks old apparently were killed and partially eaten by raccoons (*Procyon lotor*), since the tracks of this predator led to the nest bush in which the dead young were found. A domestic cat (*Felis domesticus*) was observed

jumping from one nest to another. It is possible that the several thousand Black Vultures (*Coragyps atratus*), roosting at the Benoit, Mississippi, heronry may have preyed upon young herons, particularly those young that fell out of their nests onto the dry lake bed.

Food of Young

Food for the young was obtained mostly from "borrow pits" along the Arkansas River levee, bayous, and rice fields. Little Blue Herons, along with American and Snowy egrets, came into rice fields as soon as the fields were flooded, at a time when the rice was six inches to one foot high. This flooding was begun in May and the herons appeared promptly and continued to feed

Table 2

Foods Items of young Little Blue Herons, Listed in Order of the Number of Pellets in which Each was found.

Dytiscidae larvae (predaceous diving beetles)	20
Libellulidae nymphs (dragonflies)	17
Belostomatidae (giant water-bugs)	14
Rana pipiens (leopard frog)	13
Cambarus sp. (crayfish)	12
Arachnida (spiders)	11
Hydrophilidae larvae (water-scavenger beetles)	9
Gryllidae (crickets)	8
Lissorhoptrus simplex (rice water weevils)	8
Lepomis sp. (sunfish)	7
Tabanidae larvae (horseflies)	7
Noctuidae larvae (cutworms)	7
Notonectidae (back swimmers)	6
Undetermined fish	6
Carabidae (ground beetles)	5
Acrididae (short-horned grasshoppers)	4
Other land Coleoptera	4
Hyla cinerea (green tree frog)	4
Tettigoniidae (long-horned grasshoppers)	3
Solubea pugnax (rice stink-bug)	3
Scarabaeidae (scarab beetles)	2
Stratiomyidae (soldier flies)	2
Hydrophilidae (water-scavenger beetles)	2
Esox sp. (pike)	2
Undetermined insects	2
Elateridae (click beetles)	1
Gyrinidae? (whirligig beetles)	1
Copiphorinae (cone-headed grasshoppers)	1
Oryza sativa hull (rice)	1
Echinochloa sp. (barnyard grass)	1

in the rice fields throughout the summer. A field in which the rice had attained a height of several feet usually was deserted in favor of a field where the rice was shorter. Little Blues were seen feeding all over the rice field but usually preferred the "borrow" along the contour or levee. By feeding on crayfish (*Cambarus* sp.), a favorite food, the herons were perhaps performing a service to the farmer since crayfish are known to make holes in the levees.

Determination of food items fed to the young Little Blue Herons was revealed by examination of 50 regurgitated pellets collected beneath nests containing young from one to four weeks of age. Most of the pellets were obtained on July 11, 1953, after the section of the lake over which the herons were nesting had dried up. The young in question readily regurgitated the material when alarmed by my presence (see Table 2).

Late Summer Activity

On August 1, 1953, there were still at least 300 adult and juvenile Little Blue Herons at Swan Lake. All of the young observed were out of their nests, although several evidently had not been out more than a few days. The youngest birds observed could not fly. Most of the herons, egret, and Anhingas left the heronry by the last week in August.

Little Blues remained in the general area until about October 1, many of them feeding in the nearby rice fields. American Egrets, with which they had been feeding in the rice fields all summer and early fall, were still plentiful during the last week in October, thus remaining about a month later than the Little Blue Herons.

Summary

A nesting study of the Little Blue Heron was made at Swan Lake, near Pine Bluff, Arkansas, in 1952, 1953, and 1954. This heronry, like many in the lower Mississippi Valley, was located in an old riverbed lake surrounded by cotton fields. Only adult (blue phase) birds nested at Swan Lake. Nesting associates were the American Egret, Snowy Egret and Anhinga. Most of the birds nested in buttonbushes. The earliest recorded spring arrival date was March 13, 1954. In the courtship display the performing bird moved from an upright position to crouch twice in a sort of pumping motion. At the conclusion of the pumping it assumed a normal standing position and swayed from side to side twice. Copulation took place at the nest. All males under observation engaged in promiscuous copulation. Nest building began in late March and early April. The male gathered most of the sticks, presenting them to the female at the nest. There was much stick robbing from nests by other Little Blues, Egrets and Anhingas. Five to eight days were required for completion of a clutch, depending upon the number of eggs laid. Clutch size in 50

nests averaged 4.04 eggs. During the egg-laying period, the male remained at the nest most of the time. Incubation usually began after the laying of the second egg. The incubation period was 22 or 23 days. Both parents shared in incubation and in brooding and feeding the young. At one nest, newly-hatched young were brooded 80 per cent of the time. During the first three or four days nestlings were fed upon regurgitated food dropped into the nest by the parent. By the end of the first week the young were taking food from the parent's bill. During the second week young stood up in the nest. Parents preparing to brood sometimes used their feet to push young downward in the nest. By the third week the young were spending most of their time on branches near the nest, and at about one month were making short flights. In 30 nests, 124 eggs laid produced a total of 92 young herons two weeks of age. One or more young, two weeks of age, were produced in 28 of those 30 nests. Principal cause of egg losses appeared to be nest robbing (for sticks) by other herons, egrets, and anhingas. Tracks leading to certain nests containing dead young indicated that the raccoon probably was an important predator when the lake bottom was dry. Analysis of pellets regurgitated by young Little Blue Herons revealed at least 30 different food items, among which aquatic beetles and their larvae, dragonfly nymphs, giant water-bugs, frogs and crayfish were important.

Literature Cited

Bent, A. C.
1926 Life histories of North American marsh birds. *U. S. Nat. Mus. Bull.* No. 135: xii + 1–490 pp.

Howell, A. H.
1911 Birds of Arkansas. *U.S. Biol. Survey, Bull.* No. 38:100 pp.
1932 Florida Bird Life. (New York; Coward-McCann) xxiv + 579 pp.

Meanley, B.
1954 Nesting of the water-turkey in eastern Arkansas. *Wilson Bull.*, 66:81–88.

Sprunt, A., Jr., and E. B. Chamberlain
1949 South Carolina Bird Life. Univ. South Carolina Press: xx + 585 pp.

U. S. Fish and Wildlife Service, Stuttgart, Arkansas, September 23, 1954

ARTIFICIAL INCUBATION OF SOME NON-GALLIFORM EGGS

BY RICHARD R. GRABER

ALTHOUGH there is an extensive literature on artifical incubation of eggs of domestic chicksns and some other galliform birds, relatively little has been published concerning artificial incubation in other birds. Data gained from artificial incubation of wild birds' eggs may have great importance in several phases of ornithology. For example, might not the tolerance of the embryo for humidity or extremes of temperature be an important limiting factor in the breeding distribution of a given species? Also, why is there great variation in length of incubation period among some closely related species? By controlling and varying the conditions of temperature and moisture in the incubation chamber, many such questions could be answered at least partially. Uniformly-incubated eggs are also useful material in cytogenetic studies and studies in comparative embryology.

During the summer of 1954 I tried to determine what problems were involved in a study on artificial incubation, and gathered the few data presented, with a minimum of crude equipment and in the spare time from another project.

METHODS

As an incubator I used an asbestos-walled drying oven which measured 10 × 10 × 12 inches. I fitted it with a cartridge-type thermoregulator with a range from minus 100 to 400 degrees F. In the bottom of the oven were metal coils which provided the heat source when connected to standard 110-volt electric circuit. The incubator had two ¼-inch mesh hardware cloth shelves about equidistantly spaced in the chamber. On the bottom shelf (nearest the heating coils) I placed a shallow 9 × 9-inch cake pan which I kept filled with water as a source of moisture for the eggs. The top shelf I used as an egg tray. No fan to stir the air in the incubator was used; this probably would have greatly enhanced temperature constancy.

The question of the temperature to use in incubation was difficult to decide. Baldwin and Kendeigh's work on bird temperature (1932), and Huggins' (1941) work on egg temperatures guided me to a certain extent. Kendeigh (1940:507) stated that "Romanoff (1934) found an increased rate of growth and percentage hatch of pheasant and Bob-white embryos up to 38.3° or 38.9° C. but a distinct retardation at 40.6° C." However, since I planned to work largely with Bell's Vireos (*Vireo belli*), a common species in central Oklahoma whose nests are easily found, I tried to learn about incubation temperatures in this species. This I did by inserting a maximum-registering thermometer through the wall of a vireo nest so that the bulb rested in the

midst of the eggs. In this manner I checked a few different nests by leaving the thermometer in place over night and taking a reading on the following morning. Maximum temperatures obtained in this way on different nests were 99°, 100°, and 102° F. Outside temperatures during these tests in early June ranged from 70° to 80° F., both mornings and evenings.

I finally planned to run the incubator at about 38° C. (app. 100° F.), but the best adjustment I could make produced a range from 36.5° C. (98° F.) to 39° C. (102° F.) By keeping a maximum-registering thermometer on the egg tray I knew the maximum temperature to which any egg was exposed. Shortly after I introduced the first eggs into the incubator, its temperature range increased to a usual high of 40° C. (104° F.) from a low of 36.5° C. (98° F.). This was the usual fluctuation throughout the study, though a few times the temperature fell to 35° C. (95° F.) and rose to 41° C. (106° F). On one occasion each, the temperature rose to 42° C. (108° F.), 44.5° C. (112° F.), and 49° C. (120° F.). These 'accidents' helped show the extent of heat tolerance in Brown-headed Cowbird (*Molothrus ater*) and Cardinal (*Richmondena cardinalis*) embryos.

I had no apparatus for recording temperature or humidity, so the figures represent only my recordings. I noted temperature and relative humidity at least four times each 24 hours, and once made 19 recordings in one 17-hour period. Readings of temperature were taken from one Centigrade (–20° to 110°), and one Fahrenheit (–30° to 120°) thermometer. These were inserted in corks in the top of the incubator so that their bulbs were near the egg tray, but the bulk of the columns could be read outside the incubator. These thermometers and the maximum registering thermometers used showed good correlation in reading. I had less control of humidity in this small chamber. Relative humidity readings were taken with an aspirator-type psychrometer, by placing the end of the aspirator against a hole (which was ordinarily covered) in the top of the incubator.

The average of the total (160) recorded incubation temperatures for the entire study period (June 8 to July 11) was 37.5° C. (100° F.) The average of all humidity readings was 59.7 per cent (minimum, 40 per cent; maximum 74). Once I had put eggs into the incubator I made no further adjustment, but merely recorded the conditions that existed. Eggs were exposed to room conditions three times a day for less than one minute, at about 4:00 a.m., 12:00 p.m., and 9:00 p.m., when I turned each egg by hand. All eggs were collected in the vicinity of Cogar, Caddo County, Oklahoma, and were taken directly from nest to incubator. Each egg was numbered and weighed on a centigram balance before it was put into the incubator. The time and date of entry were recorded. I also weighed some partially-incubated eggs, and in a few cases obtained the weights of dry, freshly-hatched birds.

Results

Eggs of the Mourning Dove (*Zenaidura macroura*), Yellow-billed Cuckoo (*Coccyzus americanus*), Bell's Vireo, Brown-headed Cowbird, Cardinal, and Painted Bunting (*Passerina ciris*) were hatched successfully in the incubator, though only the ages of the vireo eggs and two of the dove eggs were known.

Table 1 summarizes part of the data on five species. The period indicated under pipping and hatching is not the true incubation period, of course, but only the period of artificial incubation.

Table 1

Partial Summary of Artificial Incubation Data

Species	Egg No.	Days and hours incubation pipped; hatched		Incubation temperature (1) Average	Minimum	Maximum	Relative Humidity Avg.	Min.	Max.
Zenaidura macroura	1	11- 1	11- 5	37 (98.5)	35 (95)	41 (106)	50	41	60%
	2	12-16	13-20	37	35	41	50	41	60%
	3	13- 0	14-13	37	35	41	50	41	60%
Coccyzus americanus	1	9- 0	9- 4	38.5 (101)	35	42.5 (108)	60	40	74%
	2	7-14	8- 0	37.5 (99.5)	35	41 (106)	54	43	66%
Molothrus ater	1		8- 7	38.5	36.5 (98)	49 (120)	58	40	74%
	2		1- 0	38 (100.5)	36.5	42 (108)	60	52	68%
	3	9-12		38.5	35	44.5 (112)	60	41	74%
	4		9-12	38.5	35	44.5	60	41	74%
Richmondena cardinalis	1		7- 0	38.5	36	48.9 (120)	58	40	70%
	2	7-10	7-18	38.5	36	48.9	60	40	74%
Passerina ciris	(2 eggs)		1-16	39 (102)	36.5	41	63	48	68%

1. Degrees Centigrade, followed by Fahrenheit equivalent (in parentheses).

Some of the species warrant more detailed discussion and tabulation. They will be considered in order of the amount of data.

Bell's Vireo Eggs

Twelve Bell's Vireo eggs (three clutches) were incubated; of these nine pipped but only five hatched (three of one clutch, one of each of the others). Of the four which pipped but did not hatch, all apparently were normally formed, and only one had not absorbed all of the external yolk. Three eggs were not pipped. I broke one of these in handling, perforated another with a minute

hole, and the third, the last egg laid in clutch 1, showed no obvious development after 16 days of incubation. Data on this species are summarized in Tables 2 and 3.

Incubation began with the second egg in clutch 1, but I believe (for reasons given below) that it began with the third egg in clutches 2 and 3.

The variation in weight of eggs from different clutches is interesting and reflected a difference in size which was conspicuous, although I made no measurements. Note difference in weights of eggs *2*, *3* and *2a*, *3a* at same age (Table 3), and the progressive increase in egg weight from the first to the last egg in the clutch, in all three clutches. Note also that the three eggs of clutch 3 which hatched were also the smallest (lightest). Egg *4*, which showed no development, lost weight at the same rate as developing eggs. Egg *1a*, which was minutely perforated, lost about half its weight in 11 days. In this period weight loss of developing eggs averaged 5.4 per cent of initial weight in clutch 1 (heavier), and about 4 per cent in clutch 2 (lighter).

TABLE 2

INCUBATION DATA FOR THOSE BELL'S VIREO EGGS IN WHICH DEVELOPMENT WAS COMPLETED

(Time counted to perforation of shell in pipping. Eggs checked at least every four hours during the day.)

Clutch No.	Egg No.	Incubation by birds		Incubator Total		Total Incubation	Incubation Temperature (1) Average	Min.	Max.	Relative Humidity Avg.	Min.
		days	hours	days	hours						
1	2	2	12	12	12	15 days 0 hrs.	37.8 (100)	35 (95)	42.5 (108)	41	62
	3	0	14	14	21	14 days 21 hrs.	38 (100)	35	44.5 (112)	41	62
2	2a	1	10	13	12	14 days 22 hrs.	37.8	35	42.5	41	62
	3a	1	10	13	12	14 days 22 hrs.	37.8	35	42.5	41	62
	4a	0	10	14	13	14 days 23 hrs.	38.3	35	42.5	41	62
3	1b	6	6	8	18	15 days 0 hrs.	37.2	35	41 (106)		
	2b	6	6	8	20	15 days 2 hrs.	37.2	35	41		
	3b	6	6	9	2	15 days 8 hrs.	37.2	35	41		

The incubation period in each case was within a few hours of 15 days, that is, to the time of pipping through the shell. The data are presented in this way because more birds pipped than hatched, and those which hatched successfully did so within about six hours of breaking the shell. Pitelka and Koestner (1942: 99) give the incubation period for this species as 14 days. The discrepancy between this figure and mine is not surprising, but it is

interesting that the artificial incubation period did not change even when natural incubation was performed on four eggs for over a third of the period. The incubation period was especially uniform within the clutch. If the period may vary from clutch to clutch (it seemed to vary slightly even under similar incubation conditions), this is of interest because the shortest possible incubation period that produces sound hatchlings obviously has the best survival value. This suggests a reason why there is much variation in incubation period among closely related species (as in *Vireo*). It is probably an important factor in 'success', i.e., broadness of distributional range or density of population among birds.

Three of the four eggs which were incubated by the parent for the longest

TABLE 3

WEIGHT RELATIONSHIP OF BELL'S VIREO EGGS

Egg	Date laid*	Date entry incubator	Weight (grams)	Second weighing date	Second weighing grams	Date and hour pipped	Weight hatched bird	Remarks
1	June 12	June 15	1.67					broken June 23
2	June 13	June 15	1.79	June 26	1.70	June 28 5:00 a.m.	1.50	hatched June 28 by 4 p.m.
3	June 14	June 14	1.81	June 26	1.70	June 29 4:00 a.m.		dead in egg June 29
4	June 15	June 15	1.82	June 26	1.73			no development after 16 days incubation
1a	June 12	June 15	1.31	June 26	.72			minutely perforated on June 19
2a	June 13	June 15	1.43	June 26	1.36	June 29 4:00 a.m.		helped from shell at pipping
3a	June 14	June 15	1.52	June 26	1.47	June 29 4:00 a.m.		dead in egg June 29
4a	June 15	June 15	1.63	June 26	1.57	June 30 5:00 a.m.		helped from shell at pipping; died shortly
1b	June 21	June 29	1.29					hatched July 8 by 11:00 a.m.
2b	June 22	June 29	1.24					hatched July 8 12:00 p.m.
3b	June 23	June 29	1.25					hatched July 8 4:00 p.m.
4b	June 24	June 29	1.35					dead in egg July 9

*All eggs laid in early morning

period hatched successfully, as opposed to two of five (that pipped) that were largely artificially incubated. However, egg *4a* might have succeeded without my interference. If temperature were a factor in the apparent reduced vitality of the birds which pipped but did not hatch, then a lower temperature would probably have favored them, in view of Romanoff's findings (see above), and the fact that Huggins (*op. cit.*) found egg temperatures of wild birds to average several degrees lower than the average temperature in my incubator. I would expect the temperature of an egg in my incubator to be at least as high as the average incubation temperature since the 'attentive' period is virtually uninterrupted.

Romanoff (1949) discussed the periods and causes of mortality in avian embryos. He pointed out several causes of death in the late critical period and "that at the end of the developmental period the cumulative effect of all unfavorable conditions may be felt." I noted that I could often hear the embryo tapping on the inside of the shell a full day before any noticeable mark could be seen. Generally the first marks were mere bulges which appeared several hours before the shell actually was perforated. The fact that three birds which died before hatching had actually perforated the shell in a place or two, made me wonder if thinning of the shell by wear in the nest is not a factor in hatching success. Eggs from my incubator were not worn much by my system of turning since I picked the egg up without rubbing it against any surface. I seriously doubt that thickness of the shell is an important factor unless the embryo is weak anyway.

Hanson (1954) has recently shown that the increasing opacity of the egg with development of the embryo has utility as a fairly accurate indicator of age in incubated eggs and in determining with which egg of the clutch incubation began, especially in whitish or non-opaque eggs. On the sixth day of natural incubation I could see by candling the eggs in sunlight that eggs *1b*, *2b*, and *3b* were equally opaque to a degree that the vascular net could just be detected. Egg *4b*, on the other hand, was much less opaque and I could see the vascular net very clearly. The first three eggs also pipped and hatched together, while *4b* pipped considerably later. After the embryo reaches a certain stage, the degree of opaqueness does not change, but until that time the feature has a practical application. (See also the table on Mourning Dove development.)

Mourning Dove Eggs

The two eggs of *Zenaidura* clutch 1 were found on June 23, and were placed in the incubator at 12:00 noon when egg *1* weighed 5.68 grams, and *2* weighed 6.24 grams. Candling in sunlight showed a distinct embryo and vascular net in egg *1* while egg *2* showed no obvious development. The later egg was also heavier in the other clutch (see Table 4). On June 26, egg *1*

weighed 5.55 grams and *2* weighed 6.24 grams. Other data on these eggs are summarized in Table 1.

On June 25 I found the first egg of clutch 2. It was being incubated in mid-morning. The second egg was laid on the morning of June 26, and I placed both eggs in the incubator on that date at 11:00 a.m., directly from the nest. Table 4 summarizes apparent development observed by candling, and other data on these eggs.

TABLE 4

DEVELOPMENT OF TWO MOURNING DOVE EGGS AS OBSERVED BY CANDLING

Date	time	Egg 3	Egg 4
June 26	11:00 a.m.	6.53 grams no obvious development	7.16 grams laid by 10:00 a.m. no obvious development
June 27	9:00 p.m.	no obvious development	no obvious development
June 28	5:00 a.m.	definite vascular net over one-fourth egg area (surface)	no obvious development
	9:00 p.m.	vascular net spread over one-half egg area	clouded in central band but no definite structure apparent
June 29	12:00 p.m.		no change apparent
	9:00 p.m.		small but distinct embryo and vascular net that covers about one-third of egg area
July 9	10:00 a.m.	egg shell bulged slightly but not pipped thru	
July 10	9:00 p.m.	hatched between these hours	
July 11	6:00 a.m.	dry at this time	
July 14	p.m.		embryo pecking inside egg shell shell not visibly marked
July 15	p.m.		egg opened; embryo dead, fully developed but some yolk not absorbed.

Three days and at least 11 hours were required for egg *4* to reach the stage of development that egg *3* had reached at 5:00 a.m. on June 28. Assuming a similar rate of development in both, the incubation period of egg *3*, largely under artificial conditions (see Table 1), was between 14 days, 16 hours, and 15 days. Fifteen days is the period in nature, according to Bent (1932:405). The average incubation temperature for the dove eggs was 37° C. (98.6° F.), and Huggins (*op. cit.*:150) found the average temperature to be 36.2° C. (97° F.) in the dove eggs he checked in nature. The correlation of incubation period in nature and in my incubator is very close for this species. Examine the comparable situation with the vireos. Huggins' (*loc. cit.*) figure for average egg temperature for three Red-eyed Vireo (*Vireo olivaceus*) eggs was 32.7° C. (91° F.). If that for Bell's Vireo is comparably low (in nature), then high incubation temperature was a likely factor in the increased incuba-

tion period (15 days as opposed to 14 in nature) of vireo eggs under artifical conditions, as well as in the increased mortality of embryos.

Brown-headed Cowbird Eggs

Data on *Molothrus* eggs are partially summarized in Tables 1 and 5. Three of five cowbird eggs(nos. *1*, *2*, and *4*) hatched in the incubator. Egg no. *3* pipped but did not hatch. When I opened this egg the following day I found that the skin of the head adhered to the shell membrane. Otherwise the embryo appeared normal. The history of these eggs deserves brief description. Egg *1* had been incubated by vireos at least one day, and was subsequently deserted for at least one day. During the 24-hour inattentive period the local weather station recorded temperature extremes of 65° to 90° F., which was probably the minimum range to which the egg was exposed. In addition it was once exposed to a temperature of 49° C. (120° F.) in the incubator, yet it hatched within nine days of these exposures. Eggs *3* and *4* were incubated by vireo hosts for at least three days before being deserted. They were unattended at least 15 hours before I placed them in the incubator. During this period of inattention they were exposed for a full night, during which there was a brief cool shower, and temperatures as given by the local weather station ranged between 61° and 87° F. On the fourth day of incubation these eggs were exposed to a temperature of 45° C. (112° F.); even so egg *3* pipped, and egg *4* hatched after 9½ days of incubation.

Table 5

Summary of Data on Weight of Cowbird Eggs and Young

Egg no.	Date entry incubator	grams	2nd date weighed	grams	Date pipped or hatched	Wt. of hatched bird (grams)
1	9 June	2.89	14 June	2.86	17 June	2.32
2	14 June	3.01			15 June	2.54
3	15 June	2.68			25 June	
4	15 June	2.88			25 June	2.30
5	19 June	2.85	26 June	2.72	(anomalous embryo died in shell)	

This apparent broad temperature tolerance of cowbird embryos would seem definitely to be advantageous in view of the breeding habits of this species. It led me to experiment by keeping three cowbird eggs on a tray in my work room where the daily temperature (in July) rose to about 102° F. and fell at night to between 70° and 85° F. I turned them as I did the incubator eggs,

but otherwise they were subject to the environment of the room. My relative humidity records of the room for this period have been lost, but figures from the weather station indicate a range from about 30 to 68 per cent. My records for June in the incubation room average about 60 per cent, but I am sure that the July average was considerably lower. The three eggs lost an average of 8.3 per cent of their initial weights in nine days, and none showed development at the end of that time.

Cowbird egg *2* came from a Painted Bunting nest, and was introduced into the incubator at the same time as the host eggs. The parasite hatched about 16 hours in advance of the host young, and all hatched within two days of entry into the incubator.

In connection with study of artificially-incubated eggs, a fascinating side project suggests itself. Observation of hatchlings introduced to foster parents offers interesting possibilities. Rather than destroy some of the hatchlings, I offered them to foster parents. I put two Painted Buntings (eggs *1* and *2*) and a Cardinal (egg *1*), which hatched about the same time, in a Painted Bunting nest after taking its contents of eggs. All of these birds fared well and fledged. There was no apparent conflict between young and adults, and the adult buntings did not seem unduly strained in keeping the entire brood fed. A Cardinal (egg *2*) which I turned over to a pair of Bell's Vireos did poorly after the third day. It seemed actually to be starving and left the nest after only six days. I doubt that it survived. This Cardinal was placed in the nest of the parents of vireo clutch 1 within a few hours of the laying of the fourth egg of the clutch. The vireos stayed within a few feet and saw me remove their eggs and leave the hatchling, yet they accepted the condition without hesitation and were bringing green larvae to the Cardinal in less than one minute. I placed egg shells in the nest with each young bird, and invariably these were removed immediately. Vireos from eggs *2* and *2a* were placed in a Bell's Vireo nest on June 29. They fledged successfully on July 10 and 11 respectively. The time required for a complete cycle of these two eggs from laying through artificial incubation and fledging was 27 days. I mention these cases because they seem to present a clear insight into certain facets of bird behavior, and I believe such experiments, if well planned, could have scientific value.

Acknowledgments

I am indebted to Dr. Richard A. Goff for valuable advice and the generous loan of equipment, and to Dr. George M. Sutton for advice on the manuscript.

Literature Cited

Baldwin, S. P. and S. C. Kendeigh

1932 Physiology of the temperature of birds. *Sci. Publ. Cleveland Mus. Nat. Hist.*, 3:i–x, 1–196 pp.

BENT, A. C.
1932 Life histories of North American gallinaceous birds. *U.S. Nat. Mus. Bull.*, 162.

HANSON, H. C.
1954 Criteria of age of incubated mallard, wood duck, and bob-white quail eggs. *Auk*, 71:267–272.

HUGGINS, R. A.
1941 Egg temperatures of wild birds under natural conditions. *Ecology*, 22:148–157.

KENDEIGH, S. C.
1940 Factors affecting length of incubation. *Auk*, 57:499–513.

PITELKA, F. A. AND E. J. KOESTNER
1942 Breeding behavior of Bell's vireo in Illinois. *Wilson Bull.*, 54:97–106.

ROMANOFF, A. L.
1949 Critical periods and causes of death in avian embryonic development. *Auk*, 66:264–270.

OKLAHOMA BIOLOGICAL SURVEY, DEPARTMENT OF ZOOLOGY, UNIVERSITY OF OKLAHOMA, NORMAN, OKLAHOMA, JANUARY 28, 1955

SUMMER ACTIVITIES OF THE LAPLAND LONGSPUR ON BAFFIN ISLAND

BY GEORGE M. SUTTON AND DAVID F. PARMELEE

FROM June 14 to August 22, 1953, we studied the birds of southern Baffin Island, while living at the Royal Canadian Air Force Base near the head of Frobisher Bay. Among the buildings the Lapland Longspur (*Calcarius lapponicus*) was the most noticeable, if not actually the commonest, bird. With the Snow Bunting (*Plectrophenax nivalis*), Horned Lark (*Eremophila alpestris*), Water-Pipit (*Anthus spinoletta*), and Semipalmated Plover (*Charadrius semipalmatus*), it was in evidence most of the time, both day and night, in the latter half of June and early July.

The longspur inhabited all wet grasslands of the vicinity, notably those of the extensive flats just north of the Base, and of Davidson Point, a mile or so west of the Base, near the mouth of the Sylvia Grinnell River (Fig. 1). Not all longspur-inhabited meadows were low, extensive and level, however. Sloping ones, of varying size and shape, but often only two or three rods wide, bordered tiny snow-fed streams among the foothills. More level ones, of greater elevation, occupied depressions on the hilltops or formed the margins of lakes. The commonest bird of rocky country and therefore of the region as a whole was, of course, the Snow Bunting; but wherever there was a wet, grassy meadow the longspur was apt to be. Wynne-Edwards (1952:385), who considered the longspur the commonest bird of the low ground at the head of Clyde Inlet, Baffin Island, in the summer of 1950, found it reaching a "density of one pair in 5–15 acres (2–6 ha.)" in the most suitable habitats —i.e., the "wet tussocky meadows." Soper (1940:14) mentions the grass tundra's being "particularly rich in nesting Lapland Longspurs . . ."

On our brief visit to a large lake (Lat. 68° 31′ N., Long. 71° 22′ W.) in the Wordie Bay district, along Baffin Island's west coast, on August 8, we saw two longspurs. They were in the only stretch of grassy tundra we found in that barren area. Along the southeast shore of Lake Amadjuak, on the other hand, we saw many longspurs on August 8 and 15. Here (Lat. 64° 38′ N., Long. 70° 28′ W.) low, wet grassland stretched in every direction about us. At Cape Dorchester (Lat. 65° 20′ N., Long. 77° 10′ W.), on August 11, the longspur was decidedly the commonest passerine bird. A vast area of grass tundra, much of it wet, lay about the lake on which our amphibious aircraft alighted.

Precisely why wet grasslands are so all-important to the longspur may be difficult to say. Availability of insect food for the nestlings, of dead grass for building material, of nest-sites not readily accessible to certain predators: these probably have a part in determining the matter. To be attractive the

terrain must be more than low and flat; if too well drained, too gravelly, too bare, it will not do. Dry, firm, thinly grassed areas just north of the Base were inhabited by Horned Larks and Semipalmated Plovers, but the longspurs lived elsewhere—a stone's throw away, in the wet, grassy places. Facts of this sort, to be appreciated fully, must be observed and experienced day after day. When a visitor first perceives the noisiness and activity of the tundra's summer birdlife he is apt to feel that the many birds about him live everywhere, but he soon learns that every bird has a special habitat.

FIG. 1. Lapland Longspur nesting habitat. Photographed August 11, 1953, near the head of Frobisher Bay, Baffin Island. Nest 8 was between grassy mounds at lower left.

Our very first observations of longspurs (June 14) were of special interest. Our plane arrived about midnight. The air was cold. We were taken to our quarters in the half-light. Yet atop a wooden pole a male longspur was singing; and below our window, near some drowsy sledge dogs, a female longspur was looking for food. The pole referred to, as well as a considerably higher flag-pole not far away, were, we were soon to learn, almost constantly in use as song-perches. At least two male longspurs of the vicinity apparently had given up flight-singing altogether and were using the poles instead. Males defending territories off to the north, away from the buildings, often sang on the wing. We never saw a bunting, lark, or pipit singing from the pole-tops.

On June 15, a raw windy day, we saw many longspurs. They were commonest in the snow-free lowlands just north of the Base, but we saw them also

on the slopes leading up to the high interior. Here the ground was half white with the remains of drifts, some of them several feet thick. Wherever we went that day we heard longspur song, but we witnessed only three flight-songs; perhaps because of the wind, most of the singing was from the ground. Buntings and longspurs seemed to be equally common in some areas, but buntings were decidedly the commoner of the two on the rocky slopes. Most of the buntings obviously were paired. As for the longspurs, we were not so sure: repeatedly we came upon a male or female by itself, feeding quietly in a grassy spot. Nowhere did we see a flock of buntings or longspurs.

Late that morning we found a longspur nest containing five eggs (Nest 1). We found it not through flushing the female, but by happening to see wings fluttering just above the ground several rods ahead of us. Curious as to why any bird, regardless of its species, would flutter in that way, we walked forward, flushed a female longspur at a distance of a few feet, and found the nest, which was deep in the turf and warmly lined with fine grasses and white ptarmigan feathers (Fig. 2). The female flew off rather slowly with tail spread wide and alighted about 15 feet away. Here she puffed out her feathers and shook herself. Though obviously perturbed, she emitted no cry. Presently she flew again, this time in narrow circles about us, alighting occasionally, but giving no callnote. The male did not appear. We marked each of the eggs with a red dot, for we were not sure that the clutch was complete. The nest was about 30 paces from a Semipalmated Plover's nest containing two eggs. The two nests, though near each other in a physical sense, were discrete ecologically; that of the longspur was in wet, spongy grassland, that of the plover in hard-packed, comparatively dry gravel.

That afternoon we returned to take photographs. Again the female longspur flushed closely, flew off without feigning injury, and circled silently. Her mate did not appear. When, now and then, she alighted for a few seconds, her manner was very broody. We concluded that, whether she had finished egg-laying or not, she was incubating in earnest.

June 16 we visited the nest again. This time the female flushed at considerable distance. One egg was resting on the other four—a result, possibly, of the female's sudden departure. The nest was sheltered to the east and northeast by a fold of turf, the ground thereabout apparently having been disturbed by construction work. Nowhere in the immediate vicinity did we see or hear a male bird.

During latter June and the first nine days of July we continued to find longspur nests almost daily (see Table I). Nest 1 was only about 300 yards north of the Base, so we visited it regularly. We usually flushed a bird from the nest, and this bird invariably was the female. Usually she did not fly until we were within three or four feet. Never did she feign injury. We

never saw the male go to the nest during the period of incubation. This statement is valid, for we spent much time in a blind placed between the longspur and plover nests.

At 11:45 p.m., June 25, Parmelee visited Nest 1, finding one chick hatched but not yet dry, another hatching and still largely in the egg. When Sutton visited the nest 3 hours and 35 minutes later (3:20 a.m., June 26), he found one young bird, completely dry, and what he thought to be four eggs. The

FIG. 2. Lapland Longspur Nest 1, showing dark eggs and lining of winter ptarmigan feathers. Photographed June 15, 1953.

second chick obviously had not emerged. When we both visited the nest at 9:30 a.m., June 26, there were three eggs and one chick. What had happened to the other chick or egg we could only guess. Both parents were near the nest, but only the male gave alarm cries. The down of the chick was pale grayish buff with dark brown tipping.

Day after day we found the one chick and three eggs in the nest. July 2 we saw the male approach the nest several times, but never with food in his mouth. We banded the well-developed nestling July 4. July 5 the nest held only the three eggs. We failed to find the young bird in the vicinity, but the

behavior of the female parent clearly indicated that the chick was not far away. It had been in the nest about nine days. The "desertion of the nest by the young on about the 9th day, with the wings still in pin feathers and three to five days more before they can fly," is discussed by Wynne-Edwards (1952:386).

Nest 2. Found June 17. Five eggs. In short grass on a foot-high tussock which was surrounded by water four inches deep; in a 10-acre meadow in the high interior a mile east of the Base; a quarter of a mile from the nest of a Snowy Owl (*Nyctea scandiaca*). The female longspur flushed at about eight feet. She feigned injury only slightly as she flew off. We did not visit the nest regularly. June 24 we watched the female go to it. She wandered about for a time, not much agitated so far as we could see, then flew in and settled promptly. On July 4 and 6 there were five chicks in the nest. July 9 the chicks were so large that the nest seemed badly overcrowded. As the brooding female flushed she gave a low twitter, a callnote new to our experience. As if in response, the male appeared and both parents gave cries of alarm.

Nest 3. June 20. Not quite finished; lined with raven feathers. In the side of a tussock about five feet from the edge of a shallow pond in muddy marshlands on Davidson Point. We found the nest not by flushing the female, but by carefully searching an area guarded by a pair of longspurs.

We did not visit this nest often. June 27 it held four eggs. The glossy black feathers of the lining curled upward and inward, almost hiding the eggs. July 2 there were still four eggs. July 12, on our last visit, there were four young birds, almost ready to leave.

Nest 4. June 20. Three eggs (probably an incomplete clutch). On Davidson Point, in the middle of a 20-foot strip of turf between two large, shallow ponds. Found by watching the female which was, when we first saw her, about fifteen yards from the nest. After standing high and looking about anxiously, she flew straight to the nest. We flushed her, ascertained the number of eggs, and saw her return to them. On the far side of one of the ponds we collected a handsome male (GMS 11717), not realizing that it was her mate. When next we visited the nest, on June 27, we found it torn out and scattered.

Nest 5. June 22. Five eggs. Deep in grass about 350 yards north of the Base, six paces from the edge of a small pond, and 50 paces from a Horned Lark nest in a bare area near a gravel pit. Lined with white ptarmigan feathers and dog fur. Found by flushing the female, which flew off without feigning injury. June 23, 24, 26, 27, and 28 we flushed the female from five eggs. June 29 there were five chicks, all of which had hatched within the preceding 24 hours. Between July 1 and July 5 one of the chicks disappeared. We visited the nest daily from July 5 to 10, invariably seeing the female (usually with food in her beak) at or near the nest. July 8 we paid special attention to the male. He was very tame. If we lay down, he approached us to within five or six feet, apparently curious rather than perturbed. His food loads were smaller than those of his mate, often consisting of one large insect, such as a crane fly (*Tipula arctica*). On July 9 the nest held four well developed young. At 12:55 a.m. and 6:40 a.m., July 10, only two young were in the nest. We failed to find the others in the vicinity. At 4:00 p.m., the nest was empty. The nestling period had been at least ten days, at most, 12 days. The young were not able to fly when they left the nest.

Nest 6. June 22. Five eggs. Near the edge of a gently sloping wet meadow a quarter of a mile southeast of the Base, in moss and grass on a comparatively dry mound. Found

by flushing the female, which flew off feigning injury only slightly. We marked the nest with a flimsy cairn of stones. The cairn fell apart and we lost the nest for some time, but we re-discovered it July 7, on which date it held four good-sized young. We did not visit it thereafter.

Nest 7. June 23. Four eggs. In moss and grass in marshy spot on slope just east of Base, about five feet from the edge of a small, shallow pond; slightly sheltered by the leaves of a tiny rhododendron, about six inches from the edge of a huge sunken rock. Found by watching (1) a feeding male; (2) a female, which suddenly appeared, chased a rival female out of sight (a distance of at least 60 yards), returned, and flew directly to the nest. Visited daily June 23 to July 8, except July 6. Three young hatched between our visits of June 27 and June 28. The egg which did not hatch remained in the nest until July 5, and was not seen thereafter. We tried to capture the female with a net, but failed. The three young left the nest between our visits of July 7 and July 8. On July 8 we found all three birds, well scattered, but still unable to fly. Both parents were feeding them. The one farthest from the nest—up the slope about 50 yards—apparently was being fed exclusively by the male. The nestling period had been at least 10 full days.

Nest 8. June 25. Five eggs. Among moss and grass in crevice between two mounds; about 14 inches above wet humus in meadow bordering rocky base of foothill, about 75 paces north of Nest 1. Found by flushing the female, which flew off without feigning injury. Visited June 26, June 27, June 28 (five eggs), and July 1 (four young). What had happened to the fifth egg or young we did not know. From July 1 to 10 we visited the nest regularly. July 5 there were only three young. That day Sutton, partly hidden among rocks 60 yards away, recorded observations from 1:10 p.m. to 2:40 p.m. The female ranged widely for food, coming in with a large mouthful of insects three times, and carrying off a fecal sac after each feeding. Haviland (1916:236) "never saw food in the bill of a bird which was feeding young." The male gathered no food, made no move to accompany his mate, did not fly to greet her when she came in, and did not go to the nest. Instead, he gave alarm notes at a rate of 19 to 22 per minute (checked with a watch) virtually without break, during the whole period. He changed position six times. For about 20 minutes he called from a hummock at nest-level half way between Sutton and the nest. He gave two calls—the familiar *ee-yee* or *chee-yee*, and a softer *yee-ur* or *your*. For a quarter of an hour he was well up the slope to the east, but his calls continued to be distinctly audible. He did not once give chase to another bird; the female did not join him; and he did not sing. The sun was warm. At 2:40 p.m. the nestlings were panting heavily. One of them, when touched with a finger, begged with mouth wide open. The sound of begging was audible to Sutton at about one foot distance, inaudible at two feet.

At 6:00 a.m., July 10, two young were in the nest, but a large moist dropping a few inches away indicated that the third had departed not long since. The two young departed from the nest before 4:20 p.m. that day, leaving before being able to fly. The nestling period had been at least nine days. The empty nest was quite clean. Haviland (*loc. cit.*) reports that nests observed by her in Lapland were "always foul."

Nest 9. June 27. Two eggs, both strikingly gray rather than brown. In clump of moss, among thin grass, in tussock seven inches above wet humus; about 60 paces south of Nest 1. A pair of longspurs was in the vicinity, but the nest probably had been deserted before we found it. We never flushed a bird from it. On July 1 Parmelee examined it carefully, finding a third egg (gray) buried in the lining. On July 2 he found a fourth egg, also gray, punctured and empty, seven paces north of the nest. We put the four eggs into the nest to see what would happen to them. On July 5 they were all there, the

empty one crushed. On July 8 another egg was broken and empty. The shell bore what appeared to be double tooth-marks, almost certainly those of a lemming. Both the Collared Lemmings (*Dicrostonyx groenlandicus*) and Brown Lemmings (*Lemmus trimucronatus*) were abundant in the area. On July 21 the nest still held two eggs, both intact.

Nest 10. June 27. Two eggs. Near the Base's dump, six paces from the water's edge in wet meadow bordering a deep pool which flanked a rocky hill. Found by flushing the female, which popped out and flew off swiftly. We marked the eggs. On June 29 we found the lining (grass only; no feathers) strewn about widely. In what remained of the nest-cup were two eggs, one of them marked. About 15 inches away, almost side by side, were two more eggs, one of them marked. Marvelling that any predator could have torn the nest out without destroying its contents, we returned the eggs to the nest-cup. They were still there, intact, July 1, on which date we collected them.

Nest 11. June 27. Six eggs. On Davidson Point, in tussock six inches above water along edge of small pond, 51 paces from Nest 3. Found by flushing the female, which flew off without feigning injury. On July 2 there were four chicks and two eggs; on July 12, one chick and one egg. The nestling was large and alert looking, as if ready to bolt, but when touched it merely crouched, making no attempt to hop or flutter away. It could not fly.

Nest 12. June 27. Five eggs. On bank of small stream, three feet from swift water a foot deep, among moss, grass, and *Cassiope tetragona;* about a hundred yards from the high-tide mark. Found by flushing the female, which ran from the nest with wings spread and flew on reaching the stream's edge. Visited on June 29: five eggs, female flushed. June 30: watched female fly at least a hundred yards to nest. July 1: five eggs, no adult bird there, nest appeared to have been disturbed. July 12: four chicks and one egg. July 16: one egg and mass of feather-sheath particles, but no droppings, in the nest; two young birds, side by side, about three feet from the nest. The female parent was close by, chirping anxiously. The young, though well feathered, could not fly.

Nest 13. July 1. Five eggs. In exposed position among lichens, moss and short grass in comparatively dry meadow several hundred yards northwest of Base; 12 paces from a shallow stream, and about 50 paces from a Semipalmated Plover's nest—the latter on still drier, more gravelly ground. We flushed the female on June 30 but failed to find the nest that day. On July 1 she flushed in the same manner, flying directly from the eggs, alighting with wings spread, and running a few feet with wings partly open. On July 6 the nest held one chick and four eggs; on July 7, four chicks and one egg. The fifth egg hatched, but we do not know when. On July 11 (raining steadily) the five young birds were wet; we saw neither parent, but the nestlings appeared to be in good condition. On July 12 we color-banded the brood, green on right leg. While receiving their bands the nestlings opened their mouths repeatedly, as if for food, but if they made any sound it was exceedingly faint. At 6:30 a.m., July 16, one nestling was still in the nest. It could not fly. We failed to find others of the brood in the vicinity.

Nest 14. July 1. Five small young. North of the Base several hundred yards, in mossy hummock about two feet from a shallow pool. About 60 paces from a Semipalmated Plover's nest which was in a drier, more gravelly area. On July 1 we saw the male go to the nest with food. On July 6 and 7 (*four* young) we saw only the female parent in the vicinity. On July 11 the nest was empty.

Nest 15. July 2. Five eggs. In marsh on Davidson Point, deeply sunk in moss and well sheltered by grass. When female flushed she flew off without feigning injury. Visited by us only once thereafter, July 12, when there were five fairly well developed young.

Nest 16. July 2. At 10:00 a.m., held three eggs and one chick; at 3:10 p.m., three chicks and one egg. In wet meadow just north of Base, about five feet from the edge of a shallow pool. Bottom of nest-cup about an inch above water-level. July 6: four young, the female close by, chirping in alarm. July 8, 9, and 10: four chicks. On July 10 we visited the nest at 1:00 a.m., 6:47 a.m., and 4:25 p.m. The young were large and evidently about ready to leave. One of them, a female, we collected (GMS 11748). Though quite well feathered it was flabby and made no attempt either to run or to fly. July 11 the nest contained two chicks only, and we failed to find the other in the vicinity. Both parent birds chirped incessantly. July 12 the nest was empty except for particles of feather-sheath.

Nest 17. July 5. Three eggs. Located in a comparatively dry spot, but close to several small shallow pools, high on slope east of Base in small rock-rimmed meadow, throughout which the principal plants were moss and lichens rather than grasses. The female, a remarkably confiding bird, we caught and banded on July 7. On July 8 we recorded observations at the nest from 9:20 a.m. to 11:30 a.m., seeing only the female except at 9:45, when a male, without food in his mouth, flew over, giving a *pit-i-tit cheer* cry, and the female instantly left the nest, following him down the slope out of sight. Within a short time she returned alone and went to the nest. At 11:30 a.m., July 8, the nest held three eggs. July 10: three chicks. On July 11 we saw the female take food to the nest, but we did not see the male. On July 16 the nest held two well developed young, both dead.

Nest 18. July 5. Four eggs. In meadow just north of Base, in moss at foot of hummock, eight paces from edge of small, shallow pool; 33 paces from Semipalmated Plover's nest in much drier, more gravelly ground. Female flushed without feigning injury. July 6: four eggs. July 7: two chicks and two eggs. July 8: four young. On July 11 we observed the male, as well as the female, taking food to the nest. On July 15 we color-banded the brood, red on right leg. On July 16 the nest held four large young. It was empty on July 21.

Nest 19. July 5. Four eggs. In damp meadow north of Base, at foot of mossy mound. Neither stream nor standing water close by. Nest held four eggs on July 7, three young and one egg July 8. The three chicks had hatched within about 24 hours. One egg did not hatch. On July 8, we saw both male and female carrying food to young. That day we caught and banded the female. We saw young in the nest as late as July 16, but on July 21 it held only the one egg.

Nest 20. July 8. Five eggs, unusual in that their ground-color was pale olive and their markings few and scattered (Fig. 3). At very edge of mossy islet in wet meadow north of Base, the islet surrounded by water several inches deep. Bottom of nest-cup less than an inch above water-level. Lining without a trace of feathers, fur, or bog cotton. When female flushed she flew off swiftly. We flushed the female on July 9 and 12 (five eggs), but the nest continued to be so wet that we were not surprised to find it deserted on July 15. The eggs were still there on July 17, one of them badly broken (embryo well developed).

Nest 21. July 8. Four well developed young. In wet meadow north of Base, between two tussocks, well sheltered by grass. Found by watching female go to it with large mouthful of food. On July 9 the four young appeared to be about ready to leave. The nest was empty on July 10. We never saw a male bird in the immediate vicinity of the nest.

Nest 22. July 9. Two chicks (one not fully hatched) and one egg. In top of islet of moss and grass in meadow in high interior several miles northeast of Base. We did not flush the female but saw her near the nest. We did not visit this nest again.

From Table I these facts are apparent: (1) Of a total of 97 eggs laid in 22 nests, 22 did not hatch, but only one of the 22 nests was utterly destroyed, contents and all, by a predator. (2) Of 75 chicks known or believed by us to have hatched, 62 apparently left the nest successfully. (3) In each of five nests, a single chick disappeared prematurely. If predation were responsible

FIG. 3. Lapland Longspur Nest 20, showing pale eggs and lining wholly of grass (without feathers or hair). Photographed July 8, 1953.

for this loss it was predation of an unusual sort, for such predators as ravens (*Corvus corax*) and weasels (*Mustela erminea*) usually make off with whole broods. (4) The average clutch-size for 19 nests was 4.5 eggs—a considerably lower figure than that reported by Sutton (1932:240) for Southampton Island, where the great majority of nests in the summer of 1930 held six eggs. In obtaining average clutch-size for the Frobisher Bay area in 1953, we decided against including Nests 4, 9, and 10 in our calculation, for the clutch might not have been complete in these nests. (5) The reproductive cycle ended soon after mid-July, there being no unusually late broods or other evidence of two-broodedness.

Nineteen of the 22 nests discussed above were lined with grass and, more or

less extensively, with white winter ptarmigan feathers, or dog hair, or both. Neither of the two grass-lined nests was successful, but this may have been a mere coincidence. Nest 3 was lined with raven body feathers and grass. In no nest did we find a single *summer* ptarmigan feather. The only ptarmigan we recorded anywhere on Baffin Island in 1953 was the Rock Ptarmigan

TABLE 1

DATA FOR LAPLAND LONGSPUR NESTS, BAFFIN ISLAND, 1953

Nest No.	Date found; contents on that date	Clutch size	Eggs known not to have hatched	Observed or estimated date for hatching of first chick	Observed latest date for young in nest	No. young known or believed to have left nest successfully
1.	June 15 (5 eggs)	5	3	June 25	July 4	1
2.	June 17 (5 eggs)	5		June 29 (est.)		5
3.	June 20 (unfinished)	4		July 2 (est.)		4
4.	June 20 (3 eggs)	3?				0
5.	June 22 (5 eggs)	5		June 29	July 9-10	4
6.	June 22 (5 eggs)	5	1	June 28 (est.)		4
7.	June 23 (4 eggs)	4	1	June 28	July 7	3
8.	June 25 (5 eggs)	5	1	July 1 (est.)		3
9.	June 27 (2 eggs)	4?	4			0
10.	June 27 (2 eggs)	4?	4			0
11.	June 27 (6 eggs)	6	1	July 2	July 11-12	5
12.	June 27 (5 eggs)	5	1	July 6 (est.)		4
13.	July 1 (5 eggs)	5		July 6	July 15-16	5
14.	July 1 (5 young)	5		July 1 (est.)		4
15.	July 2 (5 eggs)	5		July 3 (est.)		5
16.	July 2 (3 eggs, 1 young)	4		July 2	July 11	4
17.	July 5 (3 eggs)	3		July 9 (est.)	July 16 (2 dead)	0
18.	July 5 (4 eggs)	4		July 7	July 16	4
19.	July 5 (4 eggs)	4	1	July 8		3
20.	July 8 (5 eggs)	5	5			0
21.	July 8 (4 young)	4		July 1 (est.)		4
22.	July 9 (2 young, 1 egg)	3	?	July 9		?

(*Lagopus mutus*), and this species was very scarce about the head of Frobisher Bay. Blair (1936:302) discusses an interesting correlation between scarcity of ptarmigan and absence of feathers from longspur nests from 1924 to 1927 in Norway. Many nests found by him during that period contained only three or four feathers, and from two nests "feathers were lacking, the lining being entirely of dry grass."

Nesting Schedule

In the Frobisher Bay area, in 1953, egg-laying must have started about June 10. We know that in Nest 1 the first chick hatched June 25. Wynne-Edwards (1952:385) states that the incubation period in "each of two exactly known cases" at Clyde Inlet was 12 days. That being the case, the fifth egg in Nest 1 probably was laid about June 14, the first egg, June 10. Many female longspurs did not start laying this early, however; or, if they did, their nests came to grief; otherwise Table I would certainly reveal more June dates than it does among the observed or estimated earliest dates for hatching. The table clearly shows that hatching in 13 of the 22 nests started on or after July 1. Note, too, that Nest 1, our earliest nest, was far from 100% successful. Three of the five eggs did not hatch, and another probably did not hatch properly. This failure may well be attributable to severe temperatures. Meteorologists at the Base informed us that the weather was unusually mild for several days in late May and early June. Some of the pipits which started nesting during that period were successful in rearing their young. We saw young pipits, well able to fly, as early as June 30 (see Sutton and Parmelee, 1954*a*). Comparably well developed young longspurs we did not see until July 12.

In the Nettilling Lake area of Baffin Island, in 1925, Soper (1928:114) found the first longspur egg of the season on June 14. That same day he examined several nests which were completed and ready for eggs. In the Bowman Bay area, in 1929, Soper (1946:423) found "the first completed nest, with a single egg" on June 26. On Southampton Island, in 1930, first eggs for the season were laid about June 17 (Sutton, 1932:240). Taverner and Sutton (1934:80) reported June 5 as the date for the earliest egg at Churchill, Manitoba, in 1931. Bailey (1948:299) found eggs as early as June 14 in the "bleak windswept tundra" near Cape Prince of Wales, Alaska. In the "more favorable" Kotzebue Sound area he found a set of five eggs on June 1. Here the first egg could not have been laid *later* than May 28.

We were especially interested in late nests. On June 19, along the east bank of the Sylvia Grinnell River, we happened upon a female with grass in her bill, but her mate continued to give alarm cries and she would not go to her nest. Finally she dropped the grass and flew off, followed by the male. Nest 10, a late nest, came to grief through predation. Had all gone well there, the four chicks would have hatched about July 11 and left the nest about July 20. On July 19, we saw young out of the nest, but unable to fly, near the mouth of the Jordan River, 16 miles west of the Base. Our latest date for a nest with a living egg was July 9; for a nest with one or more young birds, July 16; for young birds out of the nest but unable to fly, July 19. We obtained no evidence whatever of two-broodedness (Witherby, 1948:146; Salomonsen,

1951:531; Nicholson, 1930:293), and no nest that we examined appeared to have been used twice (Wynne-Edwards, 1952:385).

Aware of Wynne-Edwards's statement (*loc. cit.*) that hatching occupied "from two to four days," we paid special attention to this part of the breeding cycle. We observed no simultaneous hatching of the whole brood; but at Nests 5, 7, and 19 the 5, 3, and 3 eggs, respectively, hatched within approximately one day; at Nest 18 the four eggs hatched within approximately two days; and at Nest 13 the 5 eggs hatched within two (possibly more than two) days. At Nest 16, one chick was in the nest when we first saw it at 10:00 a.m., July 2; by 3:10 that afternoon two more chicks had hatched. The fourth egg hatched, but we did not ascertain the time of hatching.

Behavior of Nestlings

Ornithologists who have studied the nesting of such common American birds as the Field Sparrow (*Spizella pusilla*) and Song Sparrow (*Melospiza melodia*) are familiar with the way in which a nestful of well-developed young may, whether able to fly or not, "explode" in all directions when the nest is disturbed or when the parent utters certain cries of alarm. Such behavior apparently is not characteristic of the Lapland Longspur. The tendency for the nestlings to lie low rather than flutter off probably is correlated with their inability to fly at the normal time of departure from the nest. What we have thus far reported clearly shows that young longspurs leave the nest when nine to ten days old, or a little older. Pleske's (1928:145) surmise from "analogy" that "young leave the nest after 14 days (approx.)" apparently is quite wrong. Young birds on leaving the nest are wholly unable to fly. The feather development of a flightless, 10-day old bird is well illustrated by Grinnell (1944, plates 24 and 25). So there is a brief period in midsummer when longspur nests are empty, and the flightless young—neither nestlings nor fledglings, properly speaking—are scattered here and there all over the tundra. Of the nestlings we color-banded not one did we recover. Our earliest date for a strong-flying young bird was July 12. That bird (male, GMS 11750) we shot after three of us had tried for some time to catch it in the hand. Its tail was 39 mm. long. A few tufts of natal down clung to some of the wing coverts and rump feathers. In 1937 Bray found "most young longspurs . . . awing before July 13" in the region of Fury and Hecla Strait (1943:534).

Another interesting fact about the nestling longspur (*i.e.*, the young bird *while it is in the nest*) is that it is comparatively voiceless. (In the discussion of Nest 8, see our comment about the faintness of the begging cry.) Not only do nestlings have a very weak voice; when handled or disturbed, they usually remain silent. Not so the young bird after it had left the nest. Now it gives a loud *tchip* food-cry, through which it can be located by parent or human be-

ing. A loud *chee-chee-chee,* which we heard from a young bird out of the nest on July 22, we interpreted as a food cry; but it may have been a cry of fear or distress. We heard it just after one of the parent birds had given alarm notes. A loud *chee-chee-chee* is characteristic of a frightened 12-day old bird held by its toes.

Young birds on first learning to fly have an amusing way of springing from the grass and dashing off with great assurance, only to find themselves suddenly unable to go farther, at which instant they fold their wings and flop to the ground, sometimes tumbling along on the moss as a result of the momentum. Such young birds may appear to be crippled. On July 25 we chased, and probably could have caught, such a poor flier.

Activities of Adult Males

Blair (1936:103) states that in arctic Norway the male longspur, as well as the female, incubates the eggs and broods the young. We never flushed a male from a nest though several times we saw males take food to nests containing young, and we believe that males regularly take charge of the oldest members of the brood as these flightless chicks leave the nest.

At many nests visited regularly by us we noticed that the male was much more given to voicing alarm and protest than the female. We already have discussed one case of this sort (Nest 8). Another case we observed July 3. Here we did not know where the nest was located; but the female was virtually silent while the male continued to give alarm notes of four distinct sorts—the well-known, far-carrying *ee-yee,* which has been transliterated by Haviland (1916:234) as *whee-ee,* and by Salomonsen (1951:532) as *ee-yü;* a short *ear* or *err;* a rough, sharp *chee-ah;* and the familiar *pit-ick* or *fit-ick,* which may not be an alarm note at all. The male gave these cries, and these only, over and over, in about the order used here. He did not repeat himself directly.

While nests are being built and eggs laid, singing by the males is, we presume, primarily a matter of nest-territory defense, though some midsummer singing may be advertisement for a mate. The song-period was at its height in the last week of June. Singing was not exclusively a bright weather activity. On the evening of June 23, while rain was falling steadily and the sky was cloudy and dark, we observed several males singing flight-songs. On June 30 several males sang flight-songs in the heavy fog. High wind stopped the flight-singing, however, and sometimes it stopped singing of any sort. Territory-defense through singing had its amusing aspects. On June 26, on the long slope leading eastward into the high interior, we saw two males singing together in the air, as if in complete accord. They alighted about five feet apart, each on a separate stone. Here, with heads lowered and plumage lifted, they threatened each other with wide open mouths, but remained perfectly

silent. A male observed June 23 near Nest 7 did not join his mate in driving a rival female from the nest-territory.

The longspur was the first of the passerine birds to stop singing as summer advanced. Our latest date for a flight-song, indeed for a longspur song of any sort, was July 6. That day we witnessed several scattered performances. We heard several Horned Larks singing as late as July 12, a Water-Pipit singing briefly as late as July 23, and a Snow Bunting in full song (from a rock, not from the air) as late as July 27. July, 1953, was memorable for its foul weather. The recorded mean maximum temperature for the 31-day period was 49.2° F., the mean minimum, 37.6°. Soper (1928:114) reported that in the Nettilling Lake area, in 1925, the male longspurs ceased singing about July 20. July temperatures were "fairly uniform" that year, "mornings registering from 50 to 60 degrees and at mid-day, 10 to 14 degrees higher" (1928:16). In the Bowman Bay area, in 1929, longspur singing stopped between July 12 and 15 (Soper, 1946:423).

It is our carefully considered belief that shortly after the young leave the nest the sexual bond holding males and females together breaks completely. We also are convinced that no such bond as that which holds Horned Lark families together during late summer exists among Lapland Longspurs. We are puzzled by Dalgety's (1936:582) report of seeing in Greenland, as late as August 24, "family parties which had not flocked together." Once the young leave the nests and begin to scatter, they are fed for a while by the males (if they happen to be older and leave the nest first) or by the females (if they happen to be younger and to leave the nest later). All our observations during the latter two weeks of July and first two weeks of August show clearly that adult males, adult females, and young birds were living comparatively solitary lives during that period. Repeatedly we find in our notes such entries as this: "All birds seem now to be 'singles'—single adult males, single adult females, single young birds" (Sutton, July 27); or this: "Never see family groups together and rarely see male and female together—always separate birds—a dull, ratty male, a ratty female, or a trim young one, richly colored and fat-looking" (Sutton, July 31). All adult birds which we saw August 16 appeared to be molting heavily. Pleske (1927:143, 144) reports an adult male in "perfectly fresh" winter plumage taken on New Siberia Island, August 14.

The attachment that three adult males had for each other we cannot explain. We saw these birds near Tarr Inlet, July 7, shortly after singing had stopped for the season. They fed and flew about together, though their behavior was not that of a flock. Their plumage was bright but worn-looking; their post-nuptial molt probably had begun.

Activities of Adult Females

Observers agree that the female Lapland Longspur builds the nest (Sutton, 1932:240–1; Witherby, 1948:146). We observed very little nest-building. A female with grass in her bill refused to go to the nest (June 19) probably because we were so near and so conspicuous. Near Nest 3 (not quite finished, June 20) we saw both the male and female, but only the female brought material and went to the nest. We observed little defense of nest-territories by females. On June 19 Sutton witnessed a fight, memorable for its ferocity, between two female Snow Buntings (see Sutton and Parmelee, 1954*b*:162), but we never saw female longspurs fighting in such a manner. Salomonsen (1951:528) says: "I have only a few times seen a female drive another female from its territory." At Nest 7, on June 23, we saw a female chase a rival female 60 yards or more. Birds are, we believe, more apt to be territory-conscious during the periods of egg-laying and incubating than later in the season, when food gathering requires so much effort. It is nevertheless interesting that on July 5 we saw two females approach each other closely as they gathered food in the grass. Though actually side by side, they displayed no animus.

Alarm notes of females seemed to be less varied than those of males. Both males and females frequently called *fit-ick* or *pit-ick*. The far-carrying *ee-yee* seemed to be given principally by males. A female we spent some time with on July 6 gave only one alarm note—*chure* or *ee-ure*. This seemed to be slightly more mellow than any alarm note we had heard from a male.

Activities of Young Birds

Two well-feathered young birds, which we saw together near the mouth of the Jordan River on July 19, were wholly unable to fly, but strong on their feet. They were just out of the nest and must have been siblings. Between July 19 and August 2 we never saw two or more young birds together, nor an adult bird in company with one or more young ones. This was a period of molt. Such birds as we saw were apt to be ragged looking. Sometimes they flew with difficulty.

As late as July 25 young birds that we saw in flight were stub-tailed; but from July 27 on, all young birds appeared to have full-length tails.

Pleske (1928:148) states that young birds "gather into small flocks toward the middle of August, and for some while lead a nomadic life." We observed the first signs of autumnal flocking on August 2. That day, near the dump, in a disturbed soil area throughout which many herbaceous plants grew, we saw a large scattered company of longspurs and buntings feeding together peaceably. Young birds seemed to be somewhat more numerous than adults. The young were not adept at reaching the seeds, many of which they tried to shake from the stalks. When they failed to find enough seeds on the ground

they pulled the stems down and trampled them, or fluttered upward, yanking at the stalks with their bills.

Nest Success, Survival of Offspring, and Predation

The fact that 17 of the 22 nests we had under observation were more or less successful, and that only one nest was known by us to have been totally destroyed by a predator, strikes us as being remarkable. The failure of Nest 20 may have been traceable to bad weather, to unfortunate choice of site, or to absence of feathers or other warm material in the lining; that of Nest 4 to our shooting of the male bird; of Nests 9 and 10 to molestation by lemmings; of Nest 17 to disappearance of the male bird, to bad weather, or to both. On July 22 a soldier brought us a stub-tailed young longspur he had found dead. So far as we know, however, no nestful of young longspurs perished during the July 17-21 cold spell so lethal to nestling pipits (see Sutton and Parmelee, 1954*a*). The fact that the numerous husky dogs did not destroy nests continues to amaze us. Foxes and weasels were extremely rare near the Base. The several Snowy Owls which nested in the vicinity preyed exclusively on lemmings. The Ravens of the neighborhood fed regularly at the Base's dump.

We found adult longspur remains in the stomach of a Pomarine Jaeger (*Stercorarius pomarinus*) collected at Lake Amadjuak, August 8, and in the stomach of a Parasitic Jaeger (*S. parasiticus*) collected near Cape Dorchester, August 11. We saw no jaegers of any species at the head of Frobisher Bay.

Descripton of Specimens

We collected four adult Lapland Longspurs, three males and one female, near the head of Frobisher Bay. Measurements in millimeters are:

GMS No.	*Sex*	*Date*	*Wing*	*Tail*	*Culmen*	*Tarsus*
11705	Male	June 17	90	62	11	21.5
11717	Male	June 20	95.5	63.5	12	21.5
11724	Male	June 25	90	58	11.5	20.5
11725	Female	June 25	87.5	57	11	20.5

Salomonsen (1951:524) believes that a Greenland race of *Calcarius lapponicus* should be recognized. He measured the bills of 57 Greenland and 36 Scandinavian male specimens, finding the former to average 14.54 mm., the latter, 13.13 mm. in length. In his opinion, Brehm's name, *subcalcaratus*, should be used for the Greenland race. He states further: "The N. American population comes nearest to *C. l. subcalcaratus* and is best referred to that form . . ." Wynne-Edwards (1953:387) refers three males and three females from Clyde Inlet to the nominate race. Unless we took our bill measurements in some manner wholly different to that of Salomonsen, our Frobisher Bay birds are smaller-billed than Greenland birds and probably should be referred also to *C. l. lapponicus*.

The four eggs (possibly an incomplete clutch) from Nest 10 were preserved. These measure: 21.5 mm. × 16.0, 22.0 × 16.0, 22.0 × 15.5, and 22.0 × 15.5 (average: 21.8 × 15.7 mm.). They are dark brown, scrawled, blotched and spotted with darker shades and with black.

Acknowledgments

We wish to thank the Arctic Institute of North America for the generous grant-in-aid which made our work on Baffin Island possible. We are especially grateful to V. C. Wynne-Edwards, of Aberdeen University, and to Derry Ellis, of McGill University, for their assistance in the field and their companionship.

Summary

1. The Lapland Longspur was one of the commonest birds at the head of Frobisher Bay, Baffin Island, in the summer of 1953. It nested almost exclusively in wet, tussocky tundra. A nest built among moss and lichens, rather than among grass, was unsuccessful.

2. Of 22 nests found by us, 20 were lined with grass and with feathers or fur. Two were lined only with grass. None had been used previously.

3. The female built the nest and incubated the eggs. During the egg-laying and incubation periods the male rarely, if ever, went to the nest. We never saw a male take food to an incubating female.

4. After the hatching of the chicks, the male was louder-voiced than the female in sounding protest while we were near the nest. During a mid-day period of observation at one nest the male devoted himself wholly to giving alarm cries, the female to feeding the chicks. At another nest, the male fed the young regularly.

5. The average clutch-size for 19 nests was 4.5 eggs.

6. Egg-laying started about June 10 and continued at least to June 29. Earliest date for a newly hatched chick, June 25; for a chick well able to fly, July 12. Latest date for a chick ready to leave the nest, July 16; for a chick out of the nest, but still unable to fly, July 19.

7. A predator scattered the lining of one nest without breaking any of the four eggs. In each of several nests a single chick disappeared prematurely. Two of four eggs in a deserted nest were chewed at, probably by a lemming.

8. Three eggs in one nest, three in another, and five in another, hatched respectively within a 24-hour period. At one nest, two of the four chicks hatched between 10:00 a.m. and 3:10 p.m. At several nests hatching of the brood extended over a two-day, or even longer, period.

9. Chicks remained in the nest nine or ten days and left while quite unable to fly. Chicks ready to leave the nest never "exploded" in all directions when disturbed.

10. We color-banded nine chicks (two broods) in hope of ascertaining the exact fledging period, but failed to recover a color-banded individual.

11. Singing was at its height during the last week in June and stopped altogether on July 6—long before it did in other passerines.

12. Pairs separated and broods scattered within a few days after the young

had left the nests. Between July 19 and August 2 we observed no longspurs in pairs or in separate family groups. After August 2 we frequently observed mixed flocks of longspurs and buntings.

Literature Cited

Bailey, A. M.
1948 Birds of arctic Alaska. Popular Series. No. 8, *Colorado Mus. Nat. Hist.* 1–317.

Blair, H. M. S.
1936 On the birds of East Finmark. *Ibis*, 1936:280–308; 429–459; 651–674.

Bray, R.
1943 Notes on the birds of Southampton Island, Baffin Island, and Melville Peninsula. (With comments by T. H. Manning). *Auk*, 60:504–536.

Dalgety, C. T.
1936 Notes on birds observed in Greenland and Baffin Land, June-September, 1934. *Ibis*, 1936:580–591.

Grinnell, L. I.
1944 Notes on breeding lapland longspurs at Churchill, Manitoba. *Auk*, 61:554–560.

Haviland, M. D.
1916 Notes on the lapland bunting on the Yenesei River. *Brit. Birds*, 9:230–238.

Nicholson, E. M.
1930 Field-notes on Greenland birds. *Ibis*, 1930:280–313; 395–428.

Pleske, T.
1928 Birds of the Eurasian tundra. *Mem. Boston Soc. Nat. Hist.*, 6: 111-485.

Salomonsen, F.
1950-51 The birds of Greenland. (Copenhagen.) Pt. 1:5–158 (1950); Pt. 2:159–348 (1951); Pt. 3:349–608 (1951).

Soper, J. D.
1928 A faunal investigation of southern Baffin Island. *Nat. Mus. Canada Bull.* 53:76–116 (Birds).
1940 Local distribution of eastern Canadian arctic birds. *Auk*, 57:13–21.
1946 Ornithological results of the Baffin Island expeditions of 1928–1929 and 1930–31, together with more recent records. *Auk*, 63: 1–24; 223–239; 418–427.

Sutton, G. M.
1932 The exploration of Southampton Island, Hudson Bay. *Mem. Carnegie Mus.*, (Pittsburgh), 12 (2), sect. 2, The Birds: 1–275.

Sutton, G. M. and D. F. Parmelee
1954*a* Survival problems of the water-pipit in Baffin Island. *Arctic*, 7:81–92.
1954*b* Nesting of the snow bunting on Baffin Island. *Wilson Bull.*, 66:159–179.

Taverner, P. A. and G. M. Sutton
1934 The birds of Churchill, Manitoba. *Ann. Carnegie Mus.*, (Pittsburgh), 23:1–83.

Witherby, H. F. (Editor)
1948 The handbook of British birds. (London; H. F. and G. Witherby) Vol. 1.

Wynne-Edwards, V. C.
1952 Zoology of the Baird Expedition (1950). I. The birds observed in central and south-east Baffin Island. *Auk*, 69:353–391.

Department of Zoology, University of Oklahoma, Norman, Oklahoma, September 27, 1954

BEHAVIORAL MIMICRY IN THE TITMICE (PARIDAE) AND CERTAIN OTHER BIRDS

BY CHARLES G. SIBLEY

NUMEROUS examples of mimicry in color and pattern are known in insects. The Batesian type, wherein a harmless animal mimics a truly dangerous or obnoxious species, is of common occurrence. The harmless mimic derives an advantage from the resemblance because enemies, by instinct or conditioning, will tend to avoid the truly dangerous species and anything which they "identify" as the same thing. Cott (1940) has reviewed the theory of mimicry in detail.

Insect mimicry has evolved primarily under the selection pressure imposed by birds. Because most insectivorous birds utilize the sense of vision in their search for food, and because birds have well-developed color perception, the mimicry of insects has evolved primarily with respect to color and pattern.

The titmice and chickadees (Paridae), which nest in cavities in trees, have apparently evolved a defensive reaction to predators which involves a mimic display of the Batesian type. In these hole-nesting birds the adult, when disturbed on the nest, often performs a display which apparently mimics a hissing, threatening snake.

Pickens (1928) described in some detail the postures and hissing sounds made by the Carolina Chickadee (*Parus carolinensis*) when disturbed while incubating. He was impressed with the resemblance between the hiss of the bird and that of a copperhead snake (*Agkistrodon contortrix*). Pickens stressed, as have many other writers, the startling, even frightening, effect on the observer.

Others who have encountered the display in the Carolina Chickadee include Bent (1946:350) who describes the sound as "an explosive little sound like a sneeze." The bird, which had not yet laid eggs, was inside the nest and responded with the hissing sound each time the tree was tapped on the outside. Dickey (Bent, *loc. cit.*) described the sound as a serpent-like hiss, not unlike a black snake, and noted that adults included the hissing sound in their alarm notes when their young were taken from the nest for examination.

Mr. William C. Dilger has kindly permitted the use of the following quotation from his notes on *P. a. atricapillus*. On June 9, 1954, he found a chickadee excavating a nest cavity in a yellow birch on Slide Mountain, Ulster County, New York. The tail of the bird was visible at the entrance as the bird worked to enlarge the cavity. To test the response of the bird, "I placed my hand over the hole and immediately felt pecking on my palm. When I parted my fingers the bird's activities became apparent. It faced the opening and swayed from side to side with wide open beak. Suddenly it would dart at my

fingers and utter a loud hiss at the same time. The effect was very snake-like and quite startling."

Griffee (Bent, *loc. cit.*:343) reports that the Oregon Black-capped Chickadee (*P. a. occidentalis*) responds to an inquiring finger poked into the entrance of the nesting hole with "a hiss and flutter of the wings."

Burleigh (1930:60) records that incubating Oregon Black-capped Chickadees refuse to leave the nest when the nest tree is tapped and will hiss vigorously and thump the sides of the cavity with the wings.

The Mountain Chickadee (*Parus gambeli*), of western North America, has also been found to utilize the "snake display." Grinnell, Dixon and Linsdale (1930:306) describe the response of an incubating bird observed when a slab of rotten wood was removed, revealing the nest. The bird "lunged, at the same time spreading its wings convulsively, and then gave a prolonged hissing sound . . ." The observer watched this performance 19 times. The wall of the cavity was struck by the wings during the convulsive lunge.

The present author elicited the hissing response from a nesting *P. gambeli* at Crescent Meadow, Sequoia National Park, Tulare County, California, on June 29, 1951. Only the hiss could be detected as the nest was in a deep woodpecker hole.

Bent (*loc. cit.*:364) also notes that the Mountain Chickadee is known to respond to disturbance while on the nest with "a loud hissing noise and a rapid fluttering of the wings . . ." Bent (p. 365) quotes Claude T. Barnes as reporting "that five tiny fledglings, in a nest that he examined, 'hissed in the manner of a snake' when he reflected light into the nest."

The Chestnut-backed Chickadee (*Parus rufescens*) was noted by Bowles (1909:56) to respond with a "sudden flutter of wings and fierce cat-like hiss" when he attempted to look into the opening of the nest cavity. Burleigh (*loc. cit.*:61) observed that this species had the same habit as *P. atricapillus* of hissing and fluttering about when the nest tree was rapped.

A Plain Titmouse (*Parus inornatus*) nesting in a bird box "suddenly exploded and hissed" when Mrs. A. S. Allen (1943:155) lifted the lid of the box. Dixon (1949:116) also noted the explosive note which "combines elements of hissing and puffing" given by incubating birds disturbed on the nest.

The present writer had an exceptional opportunity to observe the pattern of behavior accompanying the hissing when a pair of Plain Titmice occupied a nest box provided with a hinged roof. The nest box, located in a low tree near Los Gatos, Santa Clara County, California, was occupied by the birds on April 6, 1952 when nest-building was in progress. On April 14 the hinged lid was raised and a small mirror was held over the opening to permit a view of the interior. The incubating bird raised itself slightly, gaped widely

toward the mirror, spread its wings as far as the walls of the box permitted, and swayed slowly from side to side for approximately 10 seconds—then, with explosive suddenness, jumped upward emitting a loud puffing hiss with bill agape while the wings struck the sides of the nest box with an audible thump.

On several successive days the bird was similarly disturbed and always reacted in the same stereotyped manner. On April 16, for example, the activity was elicited ten times in rapid succession during a period of approximately three minutes.

The entire pattern of swaying movement and hissing sound was strongly suggestive of a snake and undeniably startling. In spite of recurrent observations I found myself repeatedly startled by the sudden upward jump and loud hiss. It is not difficult to believe that potential predators would frequently be frightened by this activity.

The "snake display" has also been recorded for a number of the European species of *Parus*. Jourdain (1929:123), noting Pickens' article, pointed out that the Great Tit (*P. major*), Coal Tit (*P. ater*) and Blue Tit (*P. caeruleus*) produced hissing sounds when disturbed on the nest. Jouard (1932) added the European form of *P. atricapillus* and Hinde (1952:148) noted the display in the Great Tit, Blue Tit and Marsh Tit (*P. palustris*).

Certain species of hole-nesting birds, other than members of the Paridae, have also evolved a hissing "snake-display." The Wryneck (*Jynx torquilla*) has a "snake-like hissing when disturbed on nest . . ." (Witherby, *et al*, 1943 (2):293; Coward, 1920). The nestlings of the Flicker (*Colaptes auratus*) are reported (Sherman, 1910:145) to begin to produce a hissing sound soon after hatching. The noise is uttered constantly, day and night, for approximately two weeks. The young cease the sound about the time they begin to exhibit fear reactions.

The Wood Warbler (*Phylloscopus sibilatrix*) of Europe builds on the ground a domed nest, with a side entrance. The nestlings give an explosive hiss when disturbed. Cox (1930) noted that in 18 instances out of 60 the nestlings hissed simultaneously when he disturbed them.

Writing of caged birds, Brooksbank (1949) records that the Cockatiel (*Nymphicus hollandicus*) will hiss like a snake if disturbed in the nest box.

As Hinde (*loc. cit.*) has remarked, the survival value of the "snake display" is obvious. The occurrence of such a display in hole-nesting species is certainly correlated with the fact that there is but one avenue of entrance and exit. The incubating bird cannot escape from a predator capable of entering the nest opening. A high survival value is thus imposed upon any mechanism capable of inducing escape reactions in the intruder. The proof of the effectiveness of an explosive hiss, with or without an accompanying sudden movement, is found in the fact that this same pattern has evolved independently in

hole-nesting birds of widely different origins. Even the Wood Warbler qualifies since its nest has but a single entrance.

The suggestion was advanced above that the "snake display" constitutes an example of behavioral Batesian mimicry. It may well be argued that an explosive hiss is of itself a startling sound and that mimicry is not necessarily involved. This viewpoint would hold that the occurrence of hissing in snakes and in hole-nesting birds is simply a matter of convergent evolution. The case for mimicry is based on the fact that many snakes are actually dangerous to possible predators on the birds and thus the harmless mimic derives an advantage by its resemblance to the harmful model.

The effectiveness of the hissing sound in frightening mammalian predators is to be found in their demonstrated sensitivity to sibilants. Rayleigh (cited by Pumphrey, 1950) showed that the sound *sss* has most of its energy in the band between 8 and 12 kilocycles per second, to which the human ear is relatively insensitive. This same band of frequencies includes the peak of sensitivity for the rat (*Rattus*). The hiss of a snake is undoubtedly far louder and more frightening to a rat than it is to a man. It is probably safe to assume that other small mammals, including predaceous species, have a sensitivity to sibilants similar to that of the rat. If so, the frightening effect on them of the hissing produced by a hole-nesting bird should be even greater than that experienced by human observers.

The gaping mouth and slow side to side swaying movement would seem to enhance the mimic effect of a snake but, as Hinde (*loc. cit.*:24) indicates, a common threat posture of the Great Tit sometimes involves just these components. Other parids, for example *P. rufescens* (personal observation), also include a side to side swaying motion in their threat postures. It would thus appear likely that the gaping and swaying movements of the "snake display," as given by a nesting parid, have been derived from movements already present in the normal threat postures of the group. An element of mimicry is present in that the gaping and swaying seem always to be included in the "snake display" but are not consistently a part of the normal threat postures. The sudden lunge and accompanying explosive hiss may well be completely new mimic components.

The resultant pattern of the display, seen in the dim light of the nest cavity, would certainly resemble a snake rather than a bird. The intruder would thus receive a series of sign stimuli, all tending to conceal their origin as a bird and to reveal it as a snake. The testimony of many startled human observers indicates the effectiveness of the display. It seems probable that the "snake display" will be found to occur in all of the cavity-nesting Paridae. The extent of its occurrence in other groups of hole-nesting birds is a matter for experimental investigation. It is to be urged that an attempt be made to

observe, and to record in detail, the pattern of movements as well as that of any sounds. It would be of additional interest to determine the point at which the motivation for the display is exhausted, in other words, how many lunges may be elicited from a bird at any one time.

Literature Cited

Allen, Amelia S.
1943 Additional notes on the birds of a Berkeley hillside. *Condor*, 45:149–157.
Bent, A. C.
1946 Life histories of North American jays, crows, and titmice. *Bull. U.S. Nat. Mus.* 191.
Bowles, J. H.
1909 Notes on *Parus rufescens* in western Washington. *Condor*, 11:55–57.
Brooksbank, A.
1949 Foreign birds for garden aviaries. London; Cage Birds.
Burleigh, T. D.
1930 Notes on the bird life of northwestern Washington. *Auk*, 47:48–63.
Cott, H. B.
1940 Adaptive coloration in animals. London; Methuen and Co.
Coward, T. A.
1920 The birds of the British Isles and their eggs. London; Frederick Warne and Co.
Cox, A. H. M.
1930 Nestling wood-warblers "hissing." *British Birds*, 23:219–220.
Dixon, K. L.
1949 Behavior of the plain titmouse. *Condor*, 51:110-136.
Grinnell, J., J. S. Dixon and J. M. Linsdale
1930 Vertebrate natural history of a section of northern California through the Lassen Peak region. *Univ. Calif. Publ. Zool.*, 5:1–594.
Hinde, R. A.
1952 The behaviour of the great tit (*Parus major*) and some other related species. *Behaviour* (Supplement II), Leiden; E. J. Brill.
Jouard, H.
1932 Notes sur la Mésange des Saules. *Alauda*, 4:79–84.
Jourdain, F. C. R.
1929 Protective mimicry of the chickadee. *Auk*, 46:123.
Pickens, A. L.
1928 Auditory protective mimicry of the chicadee [*sic*]. *Auk*, 45:302–304.
Pumphrey, R. J.
1950 Hearing. *In*: Physiological mechanisms in animal behaviour. *Symp. Soc. Exp. Biol.*, no. IV: 3–18. Cambridge University Press.
Sherman, Althea R.
1910 At the sign of the northern flicker. *Wilson Bull.*, 22:135–171.
Witherby, H. F., F. C. R. Jourdain, N. F. Ticehurst and B. W. Tucker
1943 The handbook of British birds. Vol. 2. London; H. F. and G. Witherby.

Department of Conservation, Cornell University, Ithaca, New York,
March 5, 1955

GENERAL NOTES

A possible case of polymorphism in the Lead-colored Bush-tit.—An adult male specimen of *Psaltriparus minimus* (Yale Peabody Mus. no. 7882) was collected by David H. Parsons 12 miles west of Cortez, Montezuma County, Colorado, on July 31, 1953, well within the range of *P. m. plumbeus* but with a typical plumage for that subspecies. Instead of having the usual brown cheeks and nuchal collar, it possessed black cheeks and collar. Otherwise the plumage was typical of an adult *plumbeus*. It probably was not a hybrid nor a stray from the range of the Black-cheeked Bush-tit (*P. melanotis lloydi*), as bush-tits are rather sedentary and the specimen in question was found over 300 miles from the range of *lloydi* or any other subspecies of *P. minimus*. At the time of collection, the specimen was established by Parsons to be an adult male. Subsequent examination of the skull confirmed this age determination, thus eliminating the possibility that the unusual black plumage was a manifestation of immaturity. The specimen's wing, tail and culmen were measured (50.0, 55.0 and 7.0 mm. respectively) and found not to be significantly smaller than the average of 38 other male *plumbeus* skins. Also, no other adult individuals of the Lead-colored Bush-tit with similar aberrant melanism have been reported; therefore it would seem that this specimen does not represent a discrete population.

Swarth (1914. *Auk*, 31:499-526) has advanced the theory that melanism in *Psaltriparus* is an old trait. Black coloration is to be found in the more southern bush-tits which are presumed to be older than the northern, brown-headed subspecies, due to the effects of glaciation upon the regions that the latter bush-tits now inhabit. *P. m. plumbeus* is thought to be the link between the northern and southern species because of the geographical position of its range and the occurrence of black head feathers in its juveniles. Therefore, the specimen under consideration would appear to demonstrate polymorphism in *plumbeus* by exhibiting an ancient color trait that has been suppressed through evolution but that has cropped up again in this adult bird.—Mary Anne Heimerdinger, *Conservation Program, Yale University, New Haven, Connecticut, April 15, 1954.*

Black-billed Cuckoo feeds on Monarch Butterfly.— During the fall migration of 1954 I saw more cuckoos, both Black-billed (*Coccyzus erythropthalmus*) and Yellow-billed (*C. americanus*) than I have ever seen before. These birds were seen on frequent trips to parts of New Jersey and Long Island, New York, areas in which I go birding regularly. In the latter part of September and the first two weeks of October, the cuckoos were quite numerous at Cape May Point, New Jersey. They were seen on the roads, in the hedges and on the porches around the Point and were not at all as secretive as they are at other times of the year. Monarch butterflies also were migrating and were quite plentiful at this time.

On October 9, 1954, while walking with my wife on one of the roads at Cape May Point, we watched as a Black-billed Cuckoo flew overhead and landed in a nearby cedar. As we were looking at it the cuckoo suddenly sallied forth and, with quite an audible snap of its mandibles, captured a passing monarch butterfly (*Danaus plexippus*). It flew back into the cedar with its prey. In the tree, the cuckoo held the monarch by its thorax and shifted it about in its bill, apparently applying pressure to this area. At that time, positive identification of the monarch was made with the aid of 10-power glasses. Then, very deftly, almost faster than the action could be seen, the cuckoo began to swallow the monarch, body first. The cuckoo held its bill straight upward while half of the monarch's wings protruded from its cavernous mouth. The bird was not successful in its first at-

tempt to swallow the butterfly and it regurgitated the swallowed half to repeat this process over again. On the third try, the monarch disappeared very slowly into the seemingly bottomless throat of the cuckoo. For a minute or so after this action, the bird stood very still, looking stupified. This pose was not held for long as the cuckoo soon tried for another passing monarch, making much noise with its bill. This attempt was unsuccessful.

In searching through the literature, I find one other report of monarch butterflies being eaten by birds. Brooks (1952. *Auk*, 69:89.) records Starlings (*Sturnus vulgaris*) catching and eating monarchs. Apparently, the Starlings ate the body portion of the butterflies only, as Brooks says he found the remains of the wings.—WALTER DAWN, *Bull's Island, Awendaw, South Carolina, November 1, 1954.*

A May record of the White-winged Crossbill in Michigan.— On May 9, 1954, we observed a flock of about ten White-winged Crossbills (*Loxia leucoptera*) at Hartwick Pines State Park, Crawford County, Michigan. The birds were on the ground in a foot path and apparently were feeding. Dominant vegetation in the area was a mature stand of white pine (*Pinus strobus*).

The pronounced white wing-bars and the crossed bills were readily apparent as the crossbills were observed through binoculars at a distance of about 35 feet. Several Pine Siskins (*Spinus pinus*) were feeding with the crossbills.

Wood (1951. *Misc. Publ. Mus. Zool. Univ. Mich.*, no. 75:475) lists four records of the White-winged Crossbill from Charlevoix County, at the extreme northern tip of the Lower Peninsula of Michigan, during June and July, and two records from the Beaver Islands, at the northern end of Lake Michigan, in July. These areas are at least 50 miles north of the Hartwick Pines. Records from more southerly localities in Michigan extend from late October to early April. No May record for this species is mentioned for any part of Michigan.—T. WAYNE PORTER AND AELRED D. GEIS, *Department of Zoology; Department of Fisheries and Wildlife, Michigan State College, East Lansing, Michigan, September 27, 1954.*

Notes on a heron rookery in northeastern Oklahoma.— On July 25, 1954, I discovered a heron rookery one mile east of Owasso, in Tulsa County, Oklahoma. This colony is worthy of notice, as it was inhabited principally by the Little Blue Heron (*Florida caerulea*), a bird that has rarely been recorded nesting in Oklahoma.

The site of the rookery was a grove of catalpa trees averaging 20 feet high and covering an area 250 feet square. They had been completely stripped of leaves by insects. The surrounding terrain is pasture land. A small lake lies in the open pasture west of the grove. A larger lake, situated 300 feet north of the colony, is surrounded by willow and elm trees.

The discovery was made so late in the nesting season that it was not possible to determine the exact number of nesting Little Blue Herons, and what other species may have nested there. However, the Snowy Egret (*Egretta thula*) and the American Egret (*Casmerodius albus*) were identified feeding in ponds near the rookery with large groups of Little Blue Herons. On July 25 all three species were seen returning to the nesting area to roost; I estimated 500 in the flock. One immature Yellow-crowned Night Heron (*Nyctanassa violacea*) also was seen.

On July 27, I watched with Mr. O. W. Letson for a period of two hours before darkness.

We saw many herons return from their foraging trips in the surrounding countryside, singly, and in groups of from two to 23. We agreed that 500 was a conservative estimate of the total number. The farm operator, Mr. F. A. Duty, told us that the herons had been nesting there since his arrival in the spring of 1952, which means that the colony is at least three years old. On August 7 I located 179 nests in the grove of catalpa trees. They were from nine to 18 feet above the ground.

In late July, I found the population divided approximately in the following proportions: 60 per cent were birds with white plumage of the size of the Little Blue Heron, 30 per cent were adult Little Blue Herons, approximately nine per cent had the white plumage mottled with blue, which is characteristic of the Little Blue Heron molting from the immature to the adult plumage, and one per cent were American Egrets. Three Snowy Egrets were identified by Mr. Wallace Hughes, Oklahoma Game and Fish Department, on August 5.

On August 18, half of the occupants had gone, and those remaining were gathering at night in the trees on the north side of the large lake instead of in the nesting area as before. On another visit on September 22, I found them gone. The farm operator told me they were last seen on September 15.

This is the first record of the Little Blue Heron nesting in Tulsa County, and is the second nesting record for the State of Oklahoma, the first having been reported from Oklahoma County by Hughes (1952. *Wilson Bull.*, 64:160.)—JOHN S. TOMER, *4045 E. 27th. St., Tulsa, Oklahoma, November 3, 1954.*

An elevated nest of a Barn Swallow.—On July 12, 1954, in company with H. F. Borchert, T. D. Cotton and J. H. Shutts, I encountered a nest of *Hirundo rustica* on the observation tower of the Mud Lake National Wildlife Refuge, near Holt, Minnesota. The nest with its two eggs and two newly-hatched young had two interesting aspects. Located in the partially glassed-in tower room, it was 107 feet above the ground. Constructed on a ledge with little head room due to the sloping roof, the sides had an outer depth of about one and one-half inches.—JOSEPH J. HICKEY, *University of Minnesota Forestry and Biological Station, Lake Itasca, Minnesota, November 17, 1954.*

The incubation period of the Cape White-eye.—In view of the importance the genus *Zosterops* has assumed as allegedly having the shortest incubation period of any bird, the following observations on the Cape White-eye (*Zosterops pallida capensis*) are perhaps worth publishing at once. M. M. Nice (1953. *Wilson Bull.*, 65:84) cites Neunzig's statement that the incubation period of this White-eye is 10 days, but she rejects this on the grounds that he gives neither details nor authority. There is no other record of the incubation period of this species.

On November 15, 1954, I noticed a Cape White-eye building its nest in a vine on my verandah. The first egg was laid between 7:30 a.m. on November 17 and 7:15 a.m. on November 18; and the second, which completed the clutch, between 5:30 p.m. that same day and 7:15 a.m. on November 19. Incubation had begun by 6:15 p.m. on the latter day. The parents proved very close sitters. No continuous watch was kept, but I never saw the nest unoccupied and I had almost to push the bird off the nest every morning to inspect the contents. The two eggs hatched between 7:30 a.m. on November 29 and 6:45 a.m. on November 30. This gives an absolute minimum incubation time for the second egg of 11½ days from laying to hatching, a period which agrees with the accurate Australian and New Zealand periods for *Zosterops* spp., as quoted by

Nice. A fuller account of this nest, on which observations are continuing, will be published elsewhere in due course.—J. M. Winterbottom, *P.O. Box 1616, Cape Town, South Africa, November 30, 1954.*

An extension of the breeding range of the Killdeer in Florida.— Sprunt (1954. "Florida Bird Life.") reported the southernmost breeding station of the Killdeer (*Charadrius vociferus*) as being at Fort Myers, on the west coast of Florida.

On June 3, 1954, a Killdeer was collected by the author three miles northwest of Corkscrew, Collier County, Florida. Upon examination, this bird proved to be an adult female. The dilated condition of the cloaca and genital tract indicated recent egg laying. This specimen, now in the collection of the Florida State Museum, represents the southernmost breeding record of the Killdeer in Florida.

Since Howell (1932. "Florida Bird Life.") reported the southernmost breeding record of the Killdeer in Florida at Lake Istokpoga, both Stevenson (1939. *Wilson Bull.*, 51:85) and Sprunt (1949. *Auk*, 66:202) have extended its known range. The present specimen, taken some 60 miles south of Lake Istokpoga, is a third extension to the range of the Killdeer in recent years. These records suggest that this bird has not been merely overlooked in this region but that the species actually is increasing its breeding range to the southward. This view is substantiated by the fact that I have observed an increase in the number of breeding killdeers in the Fort Myers area in recent years. The current logging and cutting back of the Big Cypress Swamp may also open up new potential breeding sites for the Killdeer and permit further range extension southward.—Fred D. Bartleson, Jr., *Department of Biology, University of Florida, Gainesville, Florida, December 23, 1954.*

Notes on the myology of the Great Curassow.— Through the kindness of Drs. Leonard W. Wing and Josselyn Van Tyne, I was permitted some time ago to dissect a fresh specimen of the Great Curassow (*Crax rubra*). This bird, from San Luis Potosi, Mexico, was raised as a pet by Dr. Wing from June, 1951, until it died in late September, 1953. Since little is known about the internal anatomy of the Cracidae, and apparently nothing about *Crax rubra*, the following notes seem worthy of record.

Mm. tensores patagii longus et brevis are poorly developed, consisting of a single sheet-like belly with an over-all length of 85 mm. The insertion of the tendon of M. tensor patagii brevis is simple, attaching primarily to the surface of *M. extensor metacarpi radialis*, but it also fuses with the antibrachial fascia.

M. supracoracoideus is composed of two distinct and completely separate bellies and tendons of insertion. The more superficial belly is typical in origin and in the course of its tendon dorsolaterad through the triosseal canal. The tendon inserts on the humerus *15 mm. distal to* the junction of the humeral head and the deltoid crest. The deeper belly arises exclusively from the coracoclavicular membrane. Its tendon also passes through the triosseal canal to insert primarily at the base of the deltoid crest and its junction with the humeral head, but a smaller tendon inserts between this tendon and the tendon of the more superficial belly. Gadow and Selenka (1891. "Vögel." Bronn's Klassen und Ord. des Thier-Reichs, p. 248) say that M. supracoracoideus is bipartite in the "Rasores" and in *Tinamus* and that the tendons of both parts remain separated, but they say nothing about the insertion.

M. entepicondylo-ulnaris (="the gallinaceous muscle") is a triangular-shaped muscle, arising tendinous from the humerus in common with Mm. flexor digitorum sublimus and

pronator longus. It inserts by fleshy fibers on the proximal end of the ulna, posterior to the insertion of M. brachialis and anterior to the aponeurotic sheet which, in this species, forms most of M. flexor digitorum sublimus.

M. subcoracoideus arises by two heads. The larger head arises from the sternocoracoidal process of the coracoid and from the coracoclavicular membrane. A much smaller head arises from the medial surface of the acromion process of the scapula.

M. deltoideus major is poorly developed. It arises by a single head from the lateral surface of the scapula. There seems to be no os humeroscapulare.

M. pronator longus is actually a little shorter than *M. pronator brevis* (belly-length, 85 mm.), so that these two muscles extend about the same distance distad on the radius.

M. flexor digitorum sublimus has a typical origin from the humerus, but proximally the belly is rudimentary. From the origin, a flat, aponeurotic sheet extends the entire length of the ulna, attaches to the fascia surrounding the bases of the secondaries, and, distally, narrows to a tendon which inserts on the ulnare. On the ventral edge of this aponeurosis, a fusiform fleshy belly (45 mm. long) arises distally. Its tendon inserts on the base of the proximal phalanx of digit II.

M. extensor metacarpi radialis has a typical origin and belly, but distally its tendon fuses with the tendon of *M. extensor pollicis longus* (a well-developed muscle whose belly is 105 mm. long). The two tendons insert together.

M. abductor pollicis arises both by a strong tendon and by fleshy fibers from the tendon of *M. extensor metacarpi radialis* and also arises by a separate fleshy head from the distal surface of the extensor process of the carpometacarpus. The latter head inserts by fleshy fibers on nearly the entire length of the pollex. The more proximal head inserts through a tendinous sheet of fascia on the distal quarter of the pollex.

The following wing muscles are absent: Flexor metacarpi brevis, Flexor pollicis, Abductor indicis brevis, Proscapulohumeralis brevis.

The muscle formula of the thigh is ABCDXYAmV. As might be expected, many of the tendons are calcified.

M. piriformis pars caudofemoralis is very poorly developed. It consists of a spindle-shaped strap of muscle (belly about 90 mm. long, but only 7 mm. at maximum width), which arises and inserts by thin tendons. It arises from the dense fascia covering the depressor muscles of the tail; there seems to be no attachment to the pygostyle.

M. piriformis pars iliofemoralis is also poorly developed as compared to other birds I have dissected. It is a thin sheet of muscle arising from the ventral surface of the projecting posterior iliac crest. It inserts by fleshy fibers over a distance of 10 mm., beginning 30 mm. inferior to the proximal end of the femur.

M. iliotrochantericus medius is present but is quite small; it inserts distal to the insertion of *M. iliotrochantericus posticus.*

M. gluteus medius et minimus (almost rudimentary) is mostly semitendinous; its insertion is typical.

M. iliotibialis arises from the ilium, anteriorly by an aponeurosis and posteriorly by fleshy fibers. It is aponeurotic in the distal two-thirds of its central portion, as in *Coua caerulea.*

M. iliacus is well-developed. Its origin and insertion are typical.

M. peroneus longus is the most superficial muscle on the anterolateral aspect of the crus. Hence, it covers the bellies of *Mm. tibialis anticus* and *peroneus brevis.*

M. extensor digitorum longus is poorly developed. Its tendon is ossified; it bifurcates a little more than half way down the tarsometatarsus and, near the distal end of that bone, each tendon bifurcates again. The two medial tendons fuse and insert on digit III; one of the lateral tendons inserts on digit II, the other on digit IV.

M. obturator internus is triangular in shape and has a large component which arises from inside the pelvis. I failed to find *M. obturator externus.*—ANDREW J. BERGER, *Department of Anatomy, East Medical Building, Ann Arbor, Michigan, January 7, 1955.*

Notes on the songs of Lark Buntings.—The songs of Lark Buntings (*Calamospiza melanocorys*) are as distinctive as their plumage, although that fact has not been recognized adequately in the literature available to us. Peterson (1941. "A Field Guide to Western Birds") says the song is "sweet and trilling." Pough (1946. "Audubon Bird Guide; Eastern Land Birds.") adds that it is "warbled in a rich musical voice," and Hoffmann (1927. "Birds of the Pacific States.") speaks, correctly, of "sweet notes and trills, often interspersed with harsh notes."

The following observations are based on our tape recordings of two Lark Buntings in 1954, one on June 13, near Hugo, Lincoln County, Colorado, and the other on June 14, near Cimarron, Gray County, Kansas. The birds were conspicuous as they flitted across wheat fields and pastures where neither bushes, trees, nor rocks, and but few weeds, offered any concealment. Luckily for our recording, the buntings sang fully as well from fence posts as when on the wing. The birds usually were seen in loose groups or colonies containing from two to as many as a dozen singing males. The only other birds we saw near these colonies were occasional Horned Larks, Western Meadowlarks, Savannah Sparrows, and Lark Sparrows.

Broadly, the songs of the two Lark Buntings we recorded on tape, and of others heard but not recorded, consisted of the random use of several distinct phrases, with considerable variation in both the musical quality and pitches of the several phrases. A phrase might consist of a trill, or a buzz, or one or two notes repeated three to ten times.

In all, we recorded 16 songs from the Lark Bunting near Hugo, and 10 from the Cimarron bird. The Hugo bird averaged three to four phrases per song, and the Cimarron bird averaged six to seven phrases per song. For both birds we were able to recognize 11 different phrase types or patterns, although the repetitions of a given phrase-type were not always exactly identical.

The 11 phrase-types of these two Lark Buntings may be placed in four groups. Group A contains three types, Cardinal-like and gliding in pitch: (1) a single-note *sweet*, rising rapidly in pitch for about an octave, this note repeated four to eight times; (2) a slurred double-note *cher-wheat*, rising in pitch, usually repeated about three times; and (3) *weeta*, falling in pitch. Group B contains two types, chat-like and unmusical: (4) *chug* repeated three or four times; and (5) *chut*, repeated more rapidly, usually nine or ten times. Group C contains three types, trills or buzzes: (6) a low-pitched *buzz;* (7) a junco-like trill; and (8) a high-pitched, insect-like trill. Group D contains three types: (9) *toot* repeated four to twelve times, quality clear and piping; (10) *churt* less clear and musical than type 9; and (11) *chew*, rather cardinal-like, but not conspicuously gliding in pitch as in Group A.

The use of these song types by the two males is indicated in the following table:

Song Type Number	*Group*	*Transliteration*	*Number of times used*	
			Hugo	*Cimarron*
1	A	Cardinal-like *sweet*	15	8
2	A	Cardinal-like *cher-wheat*	4	3
3	A	Cardinal-like *weeta*	0	3
4	B	Chat-like *chug*	8	12
5	B	Chat-like *chut*	4	0
6	C	trills; low buzz	0	3
7	C	trills; Junco-like trill	1	4
8	C	trills; high, insect-like	7	9
9	D	single-note *toot*	12	10
10	D	single-note *churt*	1	9
11	D	single-note *chew*	0	1

With three exceptions, both birds began each song with Type 1 phrase. Seven of the 11 types (no. 1, 2, 4, 7, 8, 9, and 10) were used by both birds. Type 5 was used only by the Hugo bird; and Types 3, 6, and 11 were used only by the Cimarron bird. Type 4 was used eight times by the Cimarron bird as the second phrase in his songs; and Type 9 was used eight times by the Hugo bird as the second phrase in his songs.

A typical song of the Hugo Lark Bunting might be written: *sweet, sweet, sweet, sweet, sweet, sweet; toot, toot, toot, toot, toot, toot; chug, chug, chug; tr-r-r-r-r-r-r.*

A typical song of the Cimarron bird would be: *sweet, sweet, sweet, sweet, sweet; chug, chug, chug, chug; tr-r-r-r-r-r-r; toot, toot, toot, toot, toot; buz-z-z-z-z; churt, churt, churt.* —Jerry E. Stillwell and Norma J. Stillwell, *RFD #2, Fayetteville, Arkansas, December 11, 1954.*

Food-storing in the Sparrow Hawk.— The habit of food-storing in shrikes (*Lanius*) is well known and has obvious survival value. Sparrow Hawks (*Falco sparverius*) might be expected to benefit similarly from such a habit. The observations reported here indicate that food-storing is practiced by at least some Sparrow Hawks.

In February, 1949, I trapped a male Sparrow Hawk near Ann Arbor, Michigan. I kept this bird captive for six weeks, during which it became rather tame. On several occasions this bird stored excess food (usually beef heart) after it had eaten its fill. A typical incident was as follows: After feeding to repletion while on its perch in the living room, the bird flew to the kitchen with the remaining food in its talons. Here the hawk perched on a rod supporting some curtains and then, with actions which can best be described as furtive, placed the meat in the narrow space between the curtain and the wall. The hawk then flew back to its perch in the living room where I tethered it. The place in which the meat had been stored (and later removed by me) was not in sight of the hawk's perch. Twenty-four hours later I again released the falcon, having not fed it in the interim. It flew immediately to the curtain rod in the kitchen where it quite obviously searched for the meat, craning its neck and peering down behind the curtain. Pierce (1937. *Condor*, 39:140) has also reported storage of excess food by a captive Sparrow Hawk.

The behavior of the captive bird convinced me that wild Sparrow Hawks might store food, but proof of this was not obtained until recently. On January 8, 1955, David L. Hardy and I were trying to trap a male Sparrow Hawk near Lawrence, Douglas County, Kansas. This bird was hunting from a high tension line which crossed a 200-acre field

devoid of trees. From our car some 300 yards away, we saw the Sparrow Hawk fly to the ground approximately 90 feet north of the high tension line. The hawk remained on the ground for 10 to 15 seconds and then returned to its original perch on the wire with a mouse in its talons. It remained on the wire for half a minute, made no effort to eat the mouse, and then flew to the ground again near the point of capture of the mouse. The hawk hopped around for a few seconds and then flew up and hovered, first at approximately 30 feet and then at 70 feet, over the same spot on the ground. Returning to the high tension wire without the mouse, the hawk perched for 10 minutes. It then flew north again, hovered for 15 to 20 seconds over the spot, and finally flew 600 yards northeast where it perched in a tree.

We went into the field and after some searching found the warm, freshly-killed carcass of a male deer mouse (*Peromyscus maniculatus*) 84 feet north of the high tension line. The mouse was on the ground, belly down, tucked between coarse stems of a large clump of grass (*Panicum capillare*). There was no external evidence of injury although the mouse had the back of its skull crushed. The part of the field in which the mouse was captured and hidden had been planted with soybeans. Harvesting of the soybeans left a large amount of ground litter but little standing vegetation. The mouse was hidden in one of the most conspicuous clumps of grass. One interesting aspect of the hawk's behavior was the hovering over the spot where the mouse was stored. Possibly the hawk was memorizing the exact spot to make it easier to find the mouse when necessary.

On January 26, 1955, near Lawrence, Hardy and I saw a female Sparrow Hawk kill and store a male *Microtus ochrogaster* (weight, 15 grams; estimated age, three weeks). The hawk flew to the ground in two places before finally storing the mouse belly down, eight inches off the ground, in the top of a thick clump of a green grass, *Bromus inermis*. The storage site was almost 100 feet from the point of capture. The elapsed time from capture of the mouse until storage was approximately 45 seconds. The female falcon hovered over the hidden mouse after storing it, as did the male mentioned above.

The fact that the captive Sparrow Hawk mentioned earlier stored its food in an elevated place suggests that trees also might be used as storage places. If storage of surplus food is regularly practiced by Sparrow Hawks, the adverse effect on the birds of prolonged winter storms would be greatly reduced.—Harrison B. Tordoff, *Museum of Natural History, University of Kansas, Lawrence, Kansas, January 28, 1955.*

Size of home range in eight bird species in a southern Illinois swamp-thicket.— During the summer of 1950, William Hardy and the writer studied the ecology of a 13-acre tract of swamp and thicket in Jackson County, about one mile north of Murphysboro, Illinois. The study included a plot census of the breeding bird population (Brewer and Hardy, 1950. *Audubon Field Notes*, 4:303). By connecting successive points of observation as plotted on the study maps in such a way as to include the smallest possible area, it was possible to derive the minimum horizontal area utilized by many of the pairs of birds. Since plotted observations included all records of the occurrence of a pair and not merely records of actual or implied defense of a point (such as fights or scolding or singing birds), its seems better to designate the areas delimited in this manner as home ranges rather than as territories (Burt, 1943. *Jour. Mammalogy*, 24:346–352). There was evidence that in some cases the two areas were identical or nearly so.

The study tract consisted of three small ponds, each surrounded by a narrow zone of swamp dock (*Rumex verticillatus*) and mild water-pepper (*Polygonum hydropiperoides*)

and a much wider one of cat-tails (*Typha latifolia*) which gave way in some places to alternes of lizard's-tail (*Saururus cernuus*) and of peripheral, interdigitated, and interspersed second-growth thickets of pin oak (*Quercus palustris*), American elm (*Ulmus americana*), red maple (*Acer rubrum*), shellbark and shagbark hickories (*Carya laciniosa* and *C. ovata*), flowering dogwood (*Cornus florida*), and 28 other tree species. The average height of the thicket was 30 feet. The canopy was continuous and the understory consisted of a sparse growth of common ragweed (*Ambrosia artemisiifolia*), a sedge (*Carex squarrosa*), three-seeded mercury (*Acalypha virginica*), white-top (*Erigeron annuus*), spotted touch-me-not (*Impatiens biflora*), adder's-tongue (*Ophioglossum vulgatum*), and wood reedgrass (*Cinna arundinacea*). In some places poison ivy (*Rhus radicans*) and trumpet creeper (*Campsis radicans*) formed low, dense growths. A zone of weeds, shrubs, and shrubby trees occupied varying areas between the swamp and thicket habitats in several places. The characteristic plants of this transition zone were goldenrod (*Solidago altissima*), tickseed-sunflower (*Bidens aristosa*), great ragweed (*Ambrosia trifida*), swamp-milkweed (*Asclepias incarnata*), beard-tongue (*Penstemon tubaeflorus*), brambles (*Rubus allegheniensis*), smooth sumac (*Rhus glabra*), common elder (*Sambucus canadensis*), American elm, and pin oak. A narrow strip of thicket composed almost entirely of black willow (*Salix nigra*) lay along the western edge of the area. The ponds and the swamp stages made up about 41 per cent of the total area, the transition zone about 18 per cent, and the two divisions of thicket about 41 per cent. The land was nearly level. It was bounded on the north and south by similar habitats and on the east and west by cultivated fields.

The study area was visited 22 times from April 23 to August 30. Forty-two territorial males of 16 species of birds were present during that period. Home ranges were calculated for pairs whose movements were confined entirely to the study area and for which more than five observations were obtained. The arithmetic means, the extremes, and the numbers of pairs studied for eight species which satisfied these requirements are presented in the following table.

Species	Number of pairs	Mean size, acres	Range
Carolina Wren, *Thryothorus ludovicianus*	3	0.30	0.12–0.61
Catbird, *Dumetella carolinensis*	2	0.26	0.16–0.36
White-eyed Vireo, *Vireo griseus*	1	0.33	———
Yellow Warbler, *Dendroica petechia*	4	0.42	0.15–0.94
Yellow-throat *Geothlypis trichas*	5	0.56	0.24–1.09
Yellow-breasted Chat, *Icteria virens*	4	0.33	0.14–0.71
Cardinal, *Richmondena cardinalis*	5	0.37	0.31–0.45
Indigo Bunting, *Passerina cyanea*	5	0.26	0.15–0.52

Species resident on the study area but omitted from consideration were Mourning Dove (*Zenaidura macroura*), Yellow-billed Cuckoo (*Coccyzus americanus*), Carolina Chickadee (*Parus carolinensis*), Brown Thrasher (*Toxostoma rufum*), Bluebird (*Sialia sialis*), Blue-gray Gnatcatcher (*Polioptila caerulea*), Red-winged Blackbird (*Agelaius phoeniceus*), and Red-eyed Towhee (*Pipilo erythrophthalmus*).—RICHARD BREWER, *Department of Zoology, Southern Illinois University, Carbondale, Illinois, December 30, 1954.*

Number of feathers and weights of various systems in a Bald Eagle.—As far as I am aware the number of feathers has never been determined for any member of the Order Falconiformes. A yearling female Bald Eagle (*Haliaeetus leucocephalus*) was obtained in Volusia County, Florida, on January 15, 1953. While preparing this bird as a skeleton, I counted the contour feathers. The total count was 7182 feathers, distributed as follows: head 2175, neck 805, body 334, tail 139, left wing 1234 (of which 754 were on the upper surface, and 480 on the under surface), right wing 1369, left leg 551, right leg 535. It is interesting to note that the eagle had only a few more feathers than a Screech Owl (*Otus asio asio*), fewer than a Barred Owl (*Strix varia georgica*), and considerably fewer than several species of swimmers of smaller size (Brodkorb, 1951. *Quart. Jour. Florida Acad. Sci.*, 12:241–245).

The total weight of the eagle was 4082 grams. The weights of various parts of the body are given in the table below:

System	*Weight in Grams*		*Percent Body Weight*	
Integument	1044		25.58	
(Contour feathers)		(586)		(14.36)
(Down)		(91)		(2.23)
(Skin, including rhamphotheca and podotheca)		(367)		(8.99)
Muscles and nervous system	2360		57.81	
(*M. pectoralis superficialis*)		(646)		(15.83)
Skeleton	272		6.66	
Digestive tract	247		6.05	
(Esophagus)		(33)		(0.81)
(Stomach)		(27)		(0.66)
(Intestine)		(130)		(3.18)
(Liver)		(57)		(1.40)
Respiratory System	76		1.87	
(Trachea)		(17)		(0.42)
(Lungs)		(59)		(1.45)
Heart	58		1.42	
Kidneys	25		0.61	
Total	4082		100.00	

In the paper previously cited I estimated that the weight of the plumage might exceed that of the skeleton. This is substantiated by the present data; in fact, the weight of the skeleton of the eagle was less than half that of the feathers.—Pierce Brodkorb, *Department of Biology, University of Florida, Gainesville, Florida, February 18, 1955.*

ANNUAL MEETING

The Proceedings of the Thirty-sixth Annual Meeting, held at Stillwater, Oklahoma, April 7-10, 1955, will be published in the September issue of *The Wilson Bulletin*. The names of the officers elected for the ensuing year appear on the inside front cover. Leonard C. Brecher, retiring Treasurer, was elected a member of the Executive Council. Keith L. Dixon was appointed Editor of *The Wilson Bulletin*.

The proposed amendment to the Constitution changing the name to The Wilson Ornithological Society was passed unanimously and will become effective upon approval by by the State of Illinois. It is hoped that the change can be made operative prior to publication of the September issue of *The Wilson Bulletin*.

LOUIS AGASSIZ FUERTES RESEARCH GRANT

Robert G. Wolk, graduate student at Cornell University, has been awarded the Fuertes Research Grant to aid his "Analysis of Reproductive Behavior in the Black Skimmer," according to Dr. Kenneth C. Parkes, Chairman of the Research Grant Committee.

The American Museum of Natural History has announced the establishment of The Southwestern Research Station. It is located on the east slope of the Chiricahua Mountains, near Portal, Arizona, at an elevation of 5400 feet. The station makes available to scientists and students facilities for research utilizing faunal, floral, and geological features of the area. Further information may be obtained from the Director, Dr. Mont A. Cazier, Department of Insects and Spiders, American Museum of Natural History, New York 24, N.Y.

Volume 1 of "American Bird Songs," which features the voices of 60 species, chiefly of the eastern United States, is now available on two sides of a long-playing record. This well-known set of recordings made by Professors Allen and Kellogg is priced at $7.75. Orders may be placed with the Cornell University Press, 124 Roberts Place, Ithaca, New York.

THE WILSON ORNITHOLOGICAL CLUB LIBRARY

The following gifts have been received recently. From:

Reeve M. Bailey—3 reprints
William H. Behle—6 reprints
Andrew J. Berger—5 reprints
William H. Burt—3 reprints
G. Reeves Butchart—1 book
Robert T. Calef—2 reprints
Detroit Audubon Society—1 bulletin
Karl W. Haller—11 books
Marion L. Hundley—1 reprint
Ernst Mayr—6 bulletins
Margaret M. Nice—18 reprints
Fred M. Packard—11 magazines
Kenneth C. Parkes—2 reprints
Aretas A. Saunders—1 book
Walter E. Scott—1 book, 11 pamphlets
Allen W. Stokes—1 book
H. B. Tordoff—10 reprints
Josselyn Van Tyne—1 book
George J. Wallace—1 book

LETTER TO THE EDITOR

At the start of his interesting review of the value of the Christmas bird count (*Wilson Bull.* 66:184–195), Paul A. Stewart properly asks two questions: "Of what value are the Christmas bird counts? Can we enhance their value and still hold the interest of the many who make them?" Mr. Stewart competently handles this first query and carefully analyzes some 14 categories in which the Count can stand improvement. These analyses lead him to conclude in a final sentence that "the value of the counts can be enhanced without serious infringement of their popular appeal."

Professional ornithologists will, I am sure, agree that the value of the counts can be enhanced; but Mr. Stewart has, I am afraid, unwarrantedly inserted personal opinion into this last conclusion by claiming that his recommendations will not seriously detract from the present recreational appeal of the project. Certainly his recommendations have not been tested in practice nor does his paper report the results of a questionnaire sampling the reactions of Christmas bird counters to his ideas. Thus what purports to be a *conclusion* is in reality an *hypothesis.*

There is no clear-cut test of this hypothesis that I know of, but it is instructive to note that the fine winter bird census launched by *Audubon Field Notes* in 1948 has failed to demonstrate any widespread popular appeal (nor has its counterpart, the *Audubon Field Notes* breeding-bird census). After some 30 years personal contact with Christmas bird counters, I am pretty much convinced that Mr. Stewart's recommendations are laudable, but unrealistic. To avoid looking for birds near feeders, to refrain from making "squeaks" at nonstandardized intervals and with nonstandardized equipment, to make the use of bird dogs illegal on a count, to keep one's party together when crossing a very wide field, —these are absurdities to the lay mind: they minimize the species list and effectively rob the project of much of its fun.

May I submit that Christmas bird counting is based upon a largely emotional component that still has a reputable place in our materialistic society today? Professional ornithologists will all agree with Mr. Stewart's insistence on the need for honest identifications and the need for better census work. However much we may wish for other improvements in the Christmas count, let us recognize that many of these suggestions impose disciplines that most laymen will simply not accept. The Christmas bird count to them is essentially a recreational activity in which distinct elements of competition, surprise, rarities and the big list are bright and personally thrilling.

My quarrel with Mr. Stewart's paper centers, however, not so much on a conclusion which cannot be supported, but more importantly on what I think is the assumption underlying his paper: "list-chasing has no reputable place in our culture." I think it has. It has no place, I am glad to note, in *The Wilson Bulletin;* it has a definite place in *Audubon Field Notes.* It has its place as a sport, and as a sport, it is perhaps limited only by the strain it puts on the faunalists who compile regional lists and state bird books. I would hate to see the professional ornithologists destroy this stronghold of the amateur by a series of pincer movements carried out under the banner of "No More Variables."

To be perfectly fair to Mr. Stewart, I should acknowledge that his list of suggested prohibitions displays considerable restraint. What I really fear is that, even if his list were accepted by a groaning public, some less restrained colleague will offer another list. There are, of course, many other variables in bird counting that one could eliminate. Hindrances to audibility include boys with squeaky shoes and corduroy trousers, college-student automobiles with mudguards that wave in the wind, young girls that talk your head off, the ocean surf, the winds over 25 m.p.h. Variables in visibility include eye-

glass wearers who haven't had their eyesight checked this year, eye-glasses that fog up, persons who wash their cars after the count (not the night before), fanatics with telescopes, binoculars in a state of disrepair, boys who always get in front of you at the wrong moment, and trees with the same habit.

Variables in identification technique include newcomers to the club, museum men whose current field work is largely confined to foreign countries, people that do not own a copy of a Peterson field guide, and people possessing field guides with mutilated or missing pages. We could, I suspect, eliminate these variables with firmness and dispatch. Tests could be given each applicant a week before the great event. The elite would then shape up as a hard core of cold professionals intermixed with small numbers of thoroughly subdued amateurs. The Christmas Bird Count would then be on a thoroughly scientific level. But would it be democratic? And would it be fun?

If professional ornithologists need refined winter census data here in North America (as I think they do), let them popularize *Audubon Field Notes*' winter bird-population studies and tinker with this project while it is still young. The Christmas bird count is an old established institution. Its primary function is not ornithological, and it should be left to the amateurs. If our continental duck habitat continues its present rate of shrinkage, the count may ultimately be called upon to do more than serve as a harmless substitute for a nineteenth-century Christmas Day "side hunt."

Joseph J. Hickey

Department of Forestry and Wildlife Management
University of Wisconsin

North American students of bird migration can benefit greatly through an interchange of ideas with their colleagues in Europe. During the past year the undersigned has enjoyed a stimulating correspondence with three leading European authorities on the subject of migration and weather's relation to it. Believing that such intercommunication among fellow workers should be more widespread, I would urge North American students of migration to send their ideas and their reprints to the following: Dr. Holger Holgersen, Stavanger Museum, Stavanger, Norway; Dr. Gunnar Svardson, Omardsvagen 17, Bromma, Sweden; and Mr. Kenneth Williamson. Fair Isle Bird Observatory Trust, 17 India Street, Edinburgh 3, Scotland.

Aaron M. Bagg

72 Fairchild Avenue
Holyoke, Massachusetts

ORNITHOLOGICAL LITERATURE

FLORIDA BIRD LIFE. By Alexander Sprunt, Jr. Based upon and Supplementary to Florida Bird Life by Arthur H. Howell. Coward-McCann, Inc., and the National Audubon Society, New York, 1954: 8 × 10 in., xiii + 527 pp., 56 plates, 40 in color by F. L. Jacques and J. L. Dick, 65 text figs. $12.50.

Alexander Sprunt, Jr., D.Sc., of the National Audubon Society, Fellow of the American Ornithologists Union, has prepared what he states is a "revision-rewrite" of the State bird book which ornithologists have for many years recognized as one of the best. Arthur H. Howell set a standard with his 1932 volume which is hard to equal. It is a shame that the exhaustion of the small original printing of that work has brought about this hastily done book which will probably in time replace it in the minds of oncoming ornithologists as the definitive work on Florida birds.

Of the 42 introductory pages, 36 are taken up with: "Foreword," "Acknowledgments," "List of Illustrations," "Recent History of Florida Ornithology," (since 1932), "The Florida Audubon Society," "The Tropical Audubon Society," "Bird Protection in Florida," (since 1932), and "Note on the Author." The remaining six pages are given over to an emasculated version of Howell's discussion of the Physiographic Regions and Life Zones of Florida. Sprunt divides the State into four regions, Western, Northern, Central and Southern. The boundaries are, as he states, quite arbitrary. This is most obvious in that their positions show no relationship to any known natural factor in the environment. The discussion of "Position and Climate" may serve some useful purpose in attracting tourists to Florida but it certainly does not shed any light on conditions which the avifauna experiences. What information has been added contributes little, and what has been deleted detracts mightily.

The treatment accorded the "Birds of Florida" follows much the same pattern as that found in the earlier volume. This is almost a necessity in that most of the material has been lifted, in quotes, directly from that work. Some of the descriptions have been changed slightly, without noticeable improvement. Measurements, when given, are in inches and seem to have been taken from Howell. In the Foreword the author states that egg measurements have been added. This is not completely true. In a spot check, no measurements were found for the following: White-tailed Kite, Everglades Kite, Eastern Bob-White, Florida Bob-White, Florida Turkey and Limpkin. Range descriptions are usually taken (without quotes) intact from Howell.

Under the heading "History" the author has combined the nicely documented information which Howell presented in his discussion of "Haunts and Habits" and "Food." Sprunt, on occasion, has added his own observations along with information from the recent literature and other sources. For no apparent reason some of the earlier author's comments are deleted. On many occassions they are reworded with the original citations removed, making it impossible for the reader to determine whether Sprunt or someone else is responsible for the data. In other instances the original citations are left in place. This is not of much help to the reader who does not have Howell's book at hand in that all of Howell's references have been removed.

Five of Howell's distribution maps, inexplicably, have been removed. Of the remaining 65, some 25 have additional records indicated. As far as I can determine only eight of these show any extensions of range. On some occasions the validity of these extensions is open to question. Sprunt suggests that the Black Rail has extended its breeding range, on the basis of a song record by a Mockingbird. (D. J. Nicholson reported to him that he had heard a Mockingbird near Boca Grande imitating the notes of a Black Rail.)

The range of the Northern Blue Jay is extended on the basis of sight records by Sprunt and other observers. An October 13, 1946 specimen taken in Levy County is considered to be evidence of an extension of breeding range of *Dendroica dominica stoddardi* Sutton. The October date hardly constitutes a breeding record and more likely indicates migratory behavior. The wisdom of carrying to subspecies the identification of forms new to the State, in the absence of specimens, as is done in the case of *Dendrocygna bicolor helva* Wetmore, is questionable.

Sprunt comments at length on the occurrence of the Black Skimmer on inland lakes, yet the included map shows no such records at all. On the other hand some maps show new locality records (*viz.* the European Starling) without accompanying documentation in the text.

There are many inconsistencies in the taxonomic treatment. The order of presentation follows that of the A.O.U. Check-list, in general, and appropriate A.O.U. numbers are appended. However, the Gadwall is left in the genus *Chavelasmus* [*sic.*] without comment. This unexplained treatment, coupled with the placement of *Mareca* in the middle of the genus *Anas* makes for confusion. The change of *Moris* to *Morus* was overlooked. Several new forms are included which have not been accepted as valid by the check list commmittee (viz. *Dendroica dominica stoddardi* Sutton. *Hirundo erythrogaster insularis* Burleigh, and *Tyrannus dominicensis sequax* Brodkorb) with no comment by Sprunt as to why he considers them valid. Acceptance of *T. d. sequax* requires the substition of *T. d. fugax* for *T. d. dominicensis* yet the latter name is allowed to stand. Contrariwise "*chloristibon*" [*sic.*] is not used as a replacement for *Riccordia* because "official recognition of such is not current."

Strange inclusions are as follows: Green-shank (removed from Check-list of North American Birds in 1931), Ringed Turtle Dove (a domesticated stock), Key West Bob-White (removed from Check-list in 1946), Wurdeman's Heron, as *Ardea wurdemanni* Baird (currently regarded as hybrids). Odd omissions, considering some of the inclusions, are: The King Vulture (the sight record by William Bartram has now been accepted as valid by the A.O.U. Check-list Committee), and the Rock Dove which certainly exists in a feral state in many ruderal areas in Florida.

No measurements are given for forms which are reported as new to the State, although the measurements of others are faithfully transcribed from Howell. The check of literature from 1932 on was apparently not exhaustive. For example, no mention is made of the successful growth of the Eastern Glossy Ibis colony at Biven's Arm and later Lake Alice, near Gainesville, although the reports of the resident Florida Audubon Society Wardens mention it. The Noddy Tern is said never to rest on bare ground although published information (*Auk* 58:259) was available to the contrary.

It is interesting to note that of the 50 forms added to the State list, eight were apparently overlooked by Howell, five are newly described races, and four are based on sight records alone. Most of the others are best regarded as vagrants. In the case of the single sight record for the Red-shafted Flicker, reported in the Hypothetical List, it might be wise to point out that variants resembling its western ally have appeared *in situ* in the eastern stock.

The Hypothetical List includes 36 forms. It would be interesting to know what, if any, reported observations were omitted by the author for lack of adequate documentation.

The book is attractively bound, and the format is pleasing. Mr. John H. Dick has provided several additional plates which are very striking. The original color plates by F. L. Jacques which appeared in the earlier volume appear again, along with most of the original habitat photographs.—J. C. Dickinson, Jr.

SOCIAL FEEDING BEHAVIOR OF BIRDS By Austin L. Rand. Fieldiana: Zoology (Chicago Natural History Museum), Vol. 36, no. 1, 1954: 71 pp. $1.00, plus postage.

In this survey of what has been recorded of the social feeding habits of birds outside the breeding season (when there is the obviously special relationship of parents bringing food to young birds), an attempt is made to distinguish several types of behavior. The author is alert to the danger of assuming phylogenetic inferences in this type of data, and is correspondingly cautious in drawing conclusions. The simplest picture is that which obtains within the species, between individuals of the same kind. Rand discusses the social implications in such matters as the spacing of individuals, locating food and "communicating" such finds within the species, and the combining of effort by several individuals in securing a single item of prey. The attraction of food and the natural gregariousness of many birds provide the basic setting for these further developments.

The next group of situations is that in which birds of one species associate with a non-food animal, not necessarily a bird, for purposes of feeding. Here we have such cases as the cattle egret or the cowbird and large grazing mammals, and such an extreme development as the African greater honey-guide and the primitive tribesmen. In other cases one species may inadvertently provide food for another by leaving small scraps lying about, and finally we come to such instances as one bird stealing food from another, such as the oft mentioned one of the bald eagle forcing the fish hawk to give up its prey.

The most complex situation is that where several species of birds feed together, such as we find in mixed parties of insectivorous birds following a line of army ants, or a mixed flock of sea birds of several kinds. Throughout all the types of social feeding behavior one is aware of the acuity with which birds make use of small elements or small changes in their environment that provide some feeding advantage. Such occasional benefits may, in turn, lead to altered habits, but the apparent ease and rapidity with which these new habits seem to develop suggest that they may not necessarily provide reliable phylogenetic indications, as unrelated groups of birds may end up with similar social feeding patterns.

The paper opens up many problems and provides a convenient summary of a large amount of otherwise disconnected information, thus offering a basic working index to the literature of the subject.—HERBERT FRIEDMANN.

VI BULLETIN OF THE INTERNATIONAL COMMITTEE FOR BIRD PRESERVATION. Published by the International Committee for Bird Preservation, c/o British Museum (Natural History), Cromwell Road, London, SW 7, 1952: 9½ × 6 in., 248 pp., 12 shillings, six pence.

This Sixth Bulletin is the first published since 1939, and this may be a good opportunity to recall the history and object of the International Committee for Bird Preservation. It was founded in 1922 by the late T. Gilbert Pearson, then the President of the National Audubon Society. Immediately after the first World War, Dr. Pearson was very conscious of the importance of coordinating efforts all over the world to preserve the avifauna which was entering a critical phase. In many different regions bird life was decreasing alarmingly owing to human penetration, which meant excessive killing of certain species and destruction of the habitat of others. Something had to be done, and as the United States had some advance on other countries in establishing protective measures, it was natural that they should take the lead. Dr. Pearson came to Europe and met with a few people who were working along similar lines, particularly Mrs. R.

McKenna (Great Britain), P. van Thienhoven (The Netherlands) and the writer of these lines (France). The Committee thus was created. It is made up of National Sections, one in each of the countries where groups interested in the problem of bird protection can be found. Today these number nearly fifty. Each section consists of two representatives of eight institutions and societies. The scheme has worked well in promoting bird conservation ideas throughout the world, in helping and encouraging efforts of small groups and individuals, and in stirring up public interest to a considerable extent. After twenty years many important and tangible achievements have resulted.

The VI Bulletin is printed in four languages: English, French, German and Spanish, each contribution being written in one with summaries in the other three. It starts with the Declaration of Principles, stating the object and aim of the International Committee. Then come the proceedings of the VIII Conference held at Uppsala, Sweden, in 1950, the first plenary meeting since 1938, when many questions were discussed: transport of live birds, status of wildfowl, oil pollution, danger of insecticides, protection of migratory birds, protection of waders, exploitation of birds in the Antarctic islands, species threatened with extinction, and the situation of birds which are a menace to other species, adequate resolutions being adopted on all those important problems.

Following the summaries of the activities of the Panamerican and European sections (which group the national sections of the continents), comes the text of the International Convention for the Protection of Birds in Europe, established at a Conference in Paris in 1948. This constitutes one of the major successes of the Committee. The rest of the volume contains reports by the National Sections concerning the situation in the various countries.

The writer recently returned from the IX Plenary Conference held in Switzerland where he was reelected President of the Committee for a last term of four years. That term will bring his tenure of office to twenty years. Dr. Pearson had previously been President for sixteen years. In a world when transportation and contacts are becoming easier every day, but also when means of penetration and destruction are increasing continually, international organization is highly necessary, and it is to be hoped that those coming after us will develop, make more powerful and efficient the work that we have just started, and help in preserving for many generations to come the incomparable treasure that is the avifauna of the earth.—J. Delacour.

Check-list of the Birds of Great Britain and Ireland. Prepared by the List Sub-Committee. Published by the British Ornithologists' Union, 1952: 5½ × 8½ in., pp. i–xii, 1–106, paper cover. Obtainable from H. F. & G. Witherby Ltd., 5 Harwick Court, London, W.C. 1, England. Seven shillings sixpence, postage sixpence.

This is a revision of the official B.O.U. Check-list, complete to July 31, 1950, the last previous edition having been issued in 1923. The scope is Great Britain and Ireland, including the islands adjacent, except the Channel Islands. Information is presented in highly concise form beginning with the accepted scientific name for the species, with the authority and a common name, the original reference, with the type locality, and a greatly abbreviated statement of range. This is followed by the scientific names for subspecies, if any are recognized, and another line indicating status for each in the area. Where the bird is found in North America the A.O.U. common name for the species is added whenever this differs.

The classification under orders and families agrees fairly well with that of the A.O.U. list, with the same suffixes used to designate the rank of the name. A separate order is

added for the flamingos, and there is some variation in the derivation of the group name, e.g. Ardeiformes, instead of Ciconiiformes, and Ralliformes for Gruiformes. The Old World Vultures are placed in a separate family, Aegypiidae, and the family term Falconidae is extended to cover the rest of the hawks and the osprey, as well as the falcons. All of the owls are included in a single family. The genus *Colymbus* applies to the loons, while *Podiceps is* used for the grebes, as is usual in Old World writings. Generic limits are broad, all of the phalaropes being included in *Phalaropus*, our spotted sandpiper and yellowlegs (both stragglers) in *Tringa*, and all of the mergansers listed under *Mergus*, as examples.

The condensed form of presentation allows the inclusion of the 426 species together with whatever subspecies may be represented within the pagination shown above. At the close one page is devoted to an appendix listing a number of races that are not accepted, with reference to the edition of 1915 for other information of this kind. A further statement explains the scope of orders, families, genera, species, and races, with description of the methods of designating types of genera. One index covers the genera, and a second the common names, where American "and other equivalents" are given in italics. Those responsible have done a careful and painstaking job in screening records and names, with commendable conservatism in doubtful cases.

The scope of this work obviously is quite different from that of the official check-list of the American Ornithologists' Union. This B.O.U. list is the authority for the acceptance and standing of the species and subspecies for which there is accepted record within the designated limits. The details of distribution and casual occurrence within the area are left to the multitude of other volumes describing the birds of the British Isles, completely or in part. There is no need therefore for repetition here. Our task in America is broader as it is necessary to provide the detailed range in connection with the accepted list because of the far greater geographic area to be covered, and since state lists and condensed handbooks look to our check-list for this information.—ALEXANDER WETMORE.

BOWER-BIRDS. THEIR DISPLAYS AND BREEDING CYCLES. By A. J. Marshall. Oxford Univ. Press, 1954: 9¼ × 6¼ in., 208 pp., 26 plates, 21 figures. $4.80.

Though some bower-birds are brilliantly colored or ornamented, it is in behavior that this family of some 18 species of the Australia-New Guinea area is specialized. This behavior results in the building of mating stations, known as "bowers," decorated with leaves, flowers, stones, etc. This contrasts with the simpler mating behavior of the bower birds' near relatives, the crows, and the elaborate plumage adornment and physical displays of their other near relatives, the birds of paradise.

Marshall's book falls naturally into three parts: (a) birds' breeding seasons in general, (b) the bower birds, and (c) discussion of bowers.

In the first section, Marshall sketches the physical (neuro-endocrinal) basis for external factors influencing time of breeding, and the refractory period that would produce a rhythm without external controls. He examines a wide selection of breeding seasons that indicate not only that some external factors must be timing them but also that no *one* external factor can be operative in regulating them all. He stresses the very pertinent point that it is not the time of the inception of gonadal growth that is so important to the bird, but rather the time of ripening. (In some north-temperate birds the former may start in the autumn and be interrupted by winter.) This ripening varies from species to species, and from place to place, and is what, through natural selection, has ensured breeding at a time most likely to be successful. The theory of breeding seasons based

primarily on internal rhythms and, secondarily, on various external factors, including light, temperature, rainfall, food supply, and the activities of other birds of the same or other species (as with parasitic cuckoos), that may act in combination, is a welcome antidote to the views of those who, disregarding part of the evidence, would have one single simple factor, such as light, in control.

The account of each species opens with a general description of the bird and its range, then its breeding behavior and display, where known. The impression left by this section is how much is yet to be learned about bower-birds. For instance, the locality where one New Guinea species was taken is unknown; of another species we know, besides the description of the skins, only the locality whence the specimens came. The behavior of only one species is fairly well known, the Satin Bower-bird, (*Ptilonorhynchus violaceus*) in which the male makes an elaborate, avenue-like bower, the walls of which are orientated at right angles to the sun's course in the heavens, and which the bird paints, and in front of which it arranges selected objects of certain colors as "decoration." Here the male stations himself and is noisy long before the female is ready to mate. Finally the female visits the bower and is displayed to by the male, which uses the decorations from in front of the bower in his display. Copulation has not been observed at the bower, but probably occurs there, as it does in another species, the Spotted Bower-bird (*Chlamydera maculata*). The male apparently has no associations with the female away from the bower during nesting time; she builds a saucer-shaped nest and rears her young alone. After breeding, flocks of adults and young of both sexes are formed. At the other extreme Catbirds (*Ailuroedus*) apparently are monogamous, have no special display, and the male takes part in some nest duties.

The discussion points out that the bower represents a localizing or focusing of the territory-holding behavior, the favorite song perch, the song and display of passerine birds in general. Its nearest approach is in cleared display areas of certain birds of paradise, and the mound which the lyre bird scrapes together. Now, as specifically distinct as each species' plumage, the bower presumably is an adjunct to display in promoting copulation.

The bower building, Marshall thinks, arose out of a displaced nest-building drive of the male, and bower painting out of displaced courtship feeding. Marshall correlates the selected colors of the decoration objects with colors of the female or rival males, rejecting an earlier theory that the round objects used as decoration were to suggest eggs to the female and stimulate her to egg laying. Both of those views sound as if they came from a psychoanalyst's couch.

Dangerous as it is to theorize on scant data, some further suggestions and comparisons emerge. Marshall seems to think monogamous pairing is the rule in this family, but, as only the "primitive" Catbird (*Ailuroedus*) is known to help at the nest, it is possible that in some species the bower is the mating station to which any female may come, as in some other birds with small display grounds. The possibility that construction, repair, decorating and renovating of the bower may play a part in keeping the male bird occupied and "tied" to his mating station, rather than serving as a bond between the sexes should not be disregarded.

The use of a tool (a wad of material) by the Satin Bower-bird in painting its bower is one of the few instances of its sort among birds, recalling the Galapagos finch that uses a twig-probe to get at insects in crevices, and the anvil of the thrush for breaking snails. The north-south orientation of bowers of some species is the one positive case of its sort in birds, though it occurs in other animals, and it recalls the recent work indicating that homing may be oriented by using the sun in direction finding.

Such concrete expressions of behavior as bowers are excellent objects to arrange in series from simple to complex. From the "primitive" catbird without a bower, through the Toothed Catbird (*Scenopoeetes dentirostris*) with a cleared area decorated with green leaves and the Black Bower-bird (*Archboldia papuensis*) with a cleared area on which dead vegetation is placed, two lines are apparent: one, the saucer-shaped area with a central decorated "maypole" leading to the covered hut and nearby "garden" (*Amblyornis*, the Gardener Bower-bird), and the other, in which two rows of twigs are erected into an "avenue." Marshall, on this basis, makes the catbirds a family (Ailuroedidae) separate from the bower-birds, despite the fact that the evidence he presents on the Toothed Catbird is perhaps the best evidence we have that links the catbirds to the bower-birds. Further, as Stresemann has shown, they agree with the "maypole" builders in laying a plain egg, not heavily marked as with the "avenue" builders.

A tendency to fight anthropomorphism, that prevails the book is understandable when one considers the twaddle that has been written about the intelligence of these birds. But the conclusion that an aesthetic appreciation, a satisfaction given by contemplation of arrangements and colors, does not exist is better ruled out by definition rather than fact.

The illustrations are photographs of the birds, their bowers, and habitats, and microphotographs of gonadal tissues; the figures sketches of bowers, the heads of some species, and maps of ranges.—A. L. Rand

This issue of *The Wilson Bulletin* was published on July 12, 1955.

EDITOR OF THE WILSON BULLETIN

KEITH L. DIXON

Department of Wildlife Management

Agricultural and Mechanical College of Texas

College Station, Texas

ILLUSTRATIONS EDITOR

WILLIAM A. LUNK

SUGGESTIONS TO AUTHORS

Manuscripts intended for publication in *The Wilson Bulletin* should be neatly typewritten, double-spaced, and on one side only of good quality white paper. Tables should be typed on separate sheets. Before preparing these, carefully consider whether the material is best presented in tabular form. Where the value of quantitative data can be enhanced by use of appropriate statistical methods, these should be used. Follow the A. O. U. Check-List (fourth edition) and supplements thereto insofar as scientific names of United States and Canadian birds are concerned unless a satisfactory explanation is offered for doing otherwise. Use species names (binomials) unless specimens have actually been handled and subspecifically identified. Summaries of major papers should be brief but quotable. Where fewer than five papers are cited, the citations may be included in the text. All citations in "General Notes" should be included in the text. Follow carefully the style used in this issue in listing the literature cited. Photographs for illustrations should be sharp, have good contrast, and be on glossy paper. Submit prints unmounted and attach to each a brief but adequate legend. Do not write heavily on the backs of photographs. Diagrams and line drawings should be in black ink and their lettering large enough to permit reduction. The Illustrations Committee will prepare drawings, following authors' directions, at a charge of $1 an hour, the money to go into the color-plate fund. Authors are requested to return proof promptly. Extensive alterations in copy after the type has been set must be charged to the author.

A WORD TO MEMBERS

The Wilson Bulletin is not as large as we want it to be. It will become larger as funds for publication increase. The Club loses money, and the size of the *Bulletin* is cut down accordingly, each time a member fails to pay dues and is put on the 'suspended list.' Postage is used in notifying the publisher of this suspension. More postage is used in notifying the member and urging him to pay his dues. When he does finally pay he must be reinstated on the mailing list and there is a publisher's charge for this service. The *Bulletin* will become larger if members will make a point of paying their dues promptly.

NOTICE OF CHANGE OF ADDRESS

If your address changes, notify the Club immediately. Send your complete new address to the Treasurer, Ralph M. Edeburn, Dept. of Zoology, Marshall College, Huntington 1, West Virginia. He in turn will notify the publisher and editor.